

# **USATHAMA**

**U.S. Army Toxic and Hazardous Materials Agency**

**Tooele Army Depot—North Area**

**Final Preliminary Baseline Risk Assessment**

**April 2, 1993**

**Prepared for  
U.S. Army Environmental Center (formerly USATHAMA)  
Aberdeen Proving Ground, Maryland 21010-5401**

**Prepared by  
Rust Environment and Infrastructure  
(formerly SEC Donohue, Inc.)  
Grand Junction, Colorado 81506  
Under Contract No. DAAA15-90-D-0007**



**TOOELE ARMY DEPOT  
NORTH AREA**

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FINAL PRELIMINARY BASELINE  
RISK ASSESSMENT**

**PREPARED BY:  
SEC DONOHUE  
APR. 1993**

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## Acronyms/Abbreviations

BRA	Baseline Risk Assessment
CDI	Chemical Daily Intakes
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
EPA	U.S. Environmental Protection Agency
GI	Gastrointestinal
IWL	Industrial Waste Lagoon
MCL	Maximum Contaminant Level
NA	Not Available
ND	Non Detect
NOAEL	No Observed Adverse Effect Level
NPL	National Priorities List
OB/OD	Opening Burn/Open Detonation
PBRA	Preliminary Baseline Risk Assessment
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RDX	Cyclonite
RfD	RCRA Facility Investigation
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RME	Reasonable Maximum Exposure
SARA	Superfund Amendments and Reauthorization Act
SWMU	Solid Waste Management Unit
TCE	trichloroethylene
TEAD	Tooele Army Depot
TEAD-N	Tooele Army Depot, North Area
TSP	Total Suspended Particulate
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USEPA	U.S. Environmental Protection Agency
VOCs	Volatile Organic Compounds



## **EXECUTIVE SUMMARY**

The Preliminary Baseline Risk Assessment (PBRA) of Tooele North Army Depot-North Area (TEAD-N) is based on data existing before completion of the Remedial Investigation (RI). This risk evaluation is intended as a preliminary document that will be refined and revised following completion of the RI field activities.

This PBRA provides exposure assessment of chemicals and compounds identified and quantified at TEAD-N in the preliminary investigation.

Both Resource, Conservation, and Recovery Act (RCRA) Solid Waste Management Units (SWMUs) and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites are modeled as if they were all CERCLA sites. Results of the fate and transport models, as well as estimated risks, are based on either single- or highest-concentration compounds found in the presently reported data. A range in concentration could not be defined for this screening-level risk evaluation.

TEAD-N encompasses 24,732 acres and is located in Tooele County in west central Utah, approximately 35 miles southwest of Salt Lake City. Established April 7, 1942, Tooele Army Depot (North and South Areas combined) is one of the major ammunition storage and equipment maintenance installations in the United States and supports other Army installations throughout the western United States.

The PBRA is based on data available for 46 waste sites at TEAD-N. Surface soil, groundwater, and air pathways were evaluated. No permanent surface waters or associated sediments exist on TEAD-N. Twenty-three chemicals were identified for surface soils, and 43 chemicals of potential concern were selected for groundwater. There were 18 volatile organic compounds (VOCs) of concern.

Potentially exposed human populations, under current land use on-site, include workers, residents in on-site housing, school students and faculty, and security personnel. Public access to the facility is controlled, thereby limiting public exposure. Although unlikely, residential use was chosen as a future land-use exposure scenario for the industrial area and individual Sites/SWMUs outside the industrial area.

Human-exposure pathways considered to be complete for this PBRA are:

- Dermal contact with and ingestion of on-site soils by industrial workers.
- Dermal contact with and ingestion of on-site soils by workers and hypothetical future residents at specific sites outside the industrial area.
- Groundwater ingestion from downgradient wells by off-site residents.

- Inhalation of volatile organics from surface soils by off-site residents, on-site workers, residents, and hypothetical future on-site residents.
- Groundwater ingestion from downgradient wells by future on-site residents.

Chemical-specific intakes, or chronic daily intakes (CDI), were calculated for the exposure pathways identified for quantitative evaluation. Potential human-health risks, due to maximum exposures, were estimated for each chemical of concern. Carcinogenic and noncarcinogenic effects were calculated separately for each exposure scenario.

For current land-use conditions, carcinogenic risk related to on-site worker exposure to surface soils and volatilized chemicals on the industrial eastern portion of the site is estimated to be  $> 1 \text{ E}^{-06}$ , although no noncarcinogenic health hazard is indicated (see Table ES-1). Unacceptable carcinogenic risk and concern for noncarcinogenic health effects are indicated for the Open Burn/Open Detonation (OB/OD) Areas. Other sites are inactive. Carcinogenic-risk estimates for residents in on-site housing are slightly greater than  $1 \text{ E}^{-06}$ , although noncarcinogenic health effects are shown not to be of concern. Carcinogenic-risk estimates for off-site receptors are greater than  $1 \text{ E}^{-06}$ , but are within Environmental Protection Agency (EPA) remedial goals of  $1 \text{ E}^{-04}$  to  $1 \text{ E}^{-06}$  for residents consuming groundwater from Well 12 and for residents of Grantsville, Tooele, and Stockton, who are exposed to volatile organics from on-site air strippers. Potential risks from inhalation of volatile organics by students and faculty at the school in the administrative area are considered to be acceptable because carcinogenic risk and noncarcinogenic health effects were acceptable for on-site workers who experience a greater exposure frequency and duration.

The most significant carcinogenic-risk potential to hypothetical future on-site residents is  $3 \text{ E}^{-02}$ , which is related to soil exposure and groundwater ingestion at the TNT Washout Facility. This value exceeds the EPA remedial goals of  $1.0 \text{ E}^{-04}$  to  $1.0 \text{ E}^{-06}$  risk. The potential for adverse noncarcinogenic health effects also is indicated by a Hazard Index of  $4 \text{ E}^{+03}$ . The potential significant incremental cancer risk is indicated by risk estimates of  $1 \text{ E}^{-04}$  and  $7 \text{ E}^{-06}$  for hypothetical future residents exposed to surface soils on the OB/OD Areas and the Chemical Range. A concern for noncarcinogenic health effects also is indicated for exposure to soils at the OB/OD Area. A hypothetical future resident in the industrial area would be subject to unacceptable carcinogenic risk and concern for noncarcinogenic health effects, as would a resident exposed to groundwater at the capped industrial wastewater lagoon (IWL). Adverse noncarcinogenic health effects, however, would not be a concern under average-exposure levels.

The present definition of extent of contamination and the areal separation between waste sites preclude complete characterization of base-wide risk for TEAD-N. The estimated risk for off-site receptors exposed through the groundwater and air pathways would represent practicable site-wide risk to these receptors. The on-site industrial worker scenarios would represent area-wide risk for the eastern portion of TEAD-N.

Table ES-1. Total Pathway Risk

Exposure Point	Current Land Use		Future Land Use	
	Carcinogen Risk	Hazard Index	Carcinogen Risk	Hazard Index
	On-Site Worker		On-Site Resident	
Industrial Area <sup>(a)</sup>	3.9E-04 <sup>(b)</sup>	2.7E-02	7.4E-03 <sup>(b)</sup>	1.4E+01 <sup>(b)</sup>
OB/OD Areas (Site 1)	1.2E-05 <sup>(b)</sup>	2.7E+00 <sup>(b)</sup>	1.2E-04 <sup>(b)</sup>	1.2E+01 <sup>(b)</sup>
IWL (Site 2)	____ <sup>(c)</sup>	____ <sup>(c)</sup>	8.8E-05 <sup>(b)</sup>	4.9E+00 <sup>(b)</sup>
X-Ray Lagoon (Site 3)	____ <sup>(d)</sup>	____ <sup>(d)</sup>	____ <sup>(e)</sup>	2.9E-02
Chemical Range (Site 7)	____ <sup>(d)</sup>	____ <sup>(d)</sup>	7.5E-06 <sup>(b)</sup>	1.4E-01
TNT Washout Facility (Sites 10/11)	____ <sup>(d)</sup>	____ <sup>(d)</sup>	2.8E-02 <sup>(b)</sup>	4.0E+03 <sup>(b)</sup>
On-Site Resident				
On-Site Housing	1.3E-06 <sup>(b)</sup>	9.3E-06		
Off-Site Resident				
Water Well 12	4.4E-07	1.7E-02		
Water Wells 10&16	____ <sup>(e)</sup>	____ <sup>(e)</sup>		
Water Well OY	6.0E-07	2.5E-02		
Grantsville	3.1E-05 <sup>(b)</sup>	1.0E-05		
Tooele	3.8E-05 <sup>(b)</sup>	3.7E-05		
Stockton	8.9E-06 <sup>(b)</sup>	6.6E-06		

<sup>a</sup>Sanitary landfill, sewage lagoons, drum storage areas.

<sup>b</sup>Significant carcinogenic risk potential (risk > 1.0E-06) or possible adverse noncarcinogenic health effects for sensitive subpopulations (HI > 1).

<sup>c</sup>Site capped - future consumption of groundwater only.

<sup>d</sup>These sites are inactive and, therefore, not considered under the current on-site exposure scenario.

<sup>e</sup>No toxicity factors available.

Uncertainty in the risk-characterization results from limited-sample data, variability of sample types, lack of adequate background data, exposure assumptions, and developed scenarios. Many sites are incompletely characterized, and no sampling has been completed at others. The results of the fate and transport models are based on either single or the maximum concentration reported for a given chemical.

## **1.0 INTRODUCTION**

### **1.1 OVERVIEW**

The Preliminary Baseline Risk Assessment (PBRA) of Tooele Army Depot-North Area (TEAD-N) is based on data available before the Remedial Investigation (RI) has been completed. This preliminary risk evaluation serves as a decision-making tool and as guidance for the Remedial Investigation/Feasibility Study (RI/FS) activities. It is intended as a preliminary document to be revised and refined following completion of the RI activities. The following conclusions should aid in guiding the field activities of the RI.

Results of the fate and transport models, as well as estimated risks, are based on either single or the highest concentration of the compounds found in the presently reported data. A range in concentration could not be defined for this screening-level risk evaluation.

### **1.2 PURPOSE**

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by The Superfund Amendments and Reauthorization Act (SARA), requires a Baseline Risk Assessment (BRA) to be developed as part of the RI/FS process at National Priorities List (NPL) sites.

This PBRA provides exposure assessment of chemicals and compounds identified and quantified at TEAD-N in the preliminary investigation.

Both Resource, Conservation, and Recovery Act (RCRA) solid waste management units (SWMUs) and CERCLA sites are modeled as if they were all CERCLA sites. Following completion of the on-going RI/FS and the RCRA Facility Investigation (RFI) at TEAD-N, this PBRA will be further refined and developed into an in-depth BRA using comprehensive site data to refine exposure assessment and risk-characterization models.

### **1.3 SITE LOCATION**

TEAD-N encompasses 24,732 acres and is located in Tooele County in west central Utah, approximately 35 miles southwest of Salt Lake City (see Figure 1-1). It is adjacent to the west boundary of the city of Tooele, approximately 2.5 miles south of Grantsville, and 4 miles north by northwest of Stockton, Utah.

### **1.4 INSTALLATION DESCRIPTION AND HISTORY**

Established April 7, 1942, Tooele Army Depot (North and South Areas combined) is one of the major ammunition-storage and equipment-maintenance installations in the United States and supports other Army installations throughout the western United States. The current

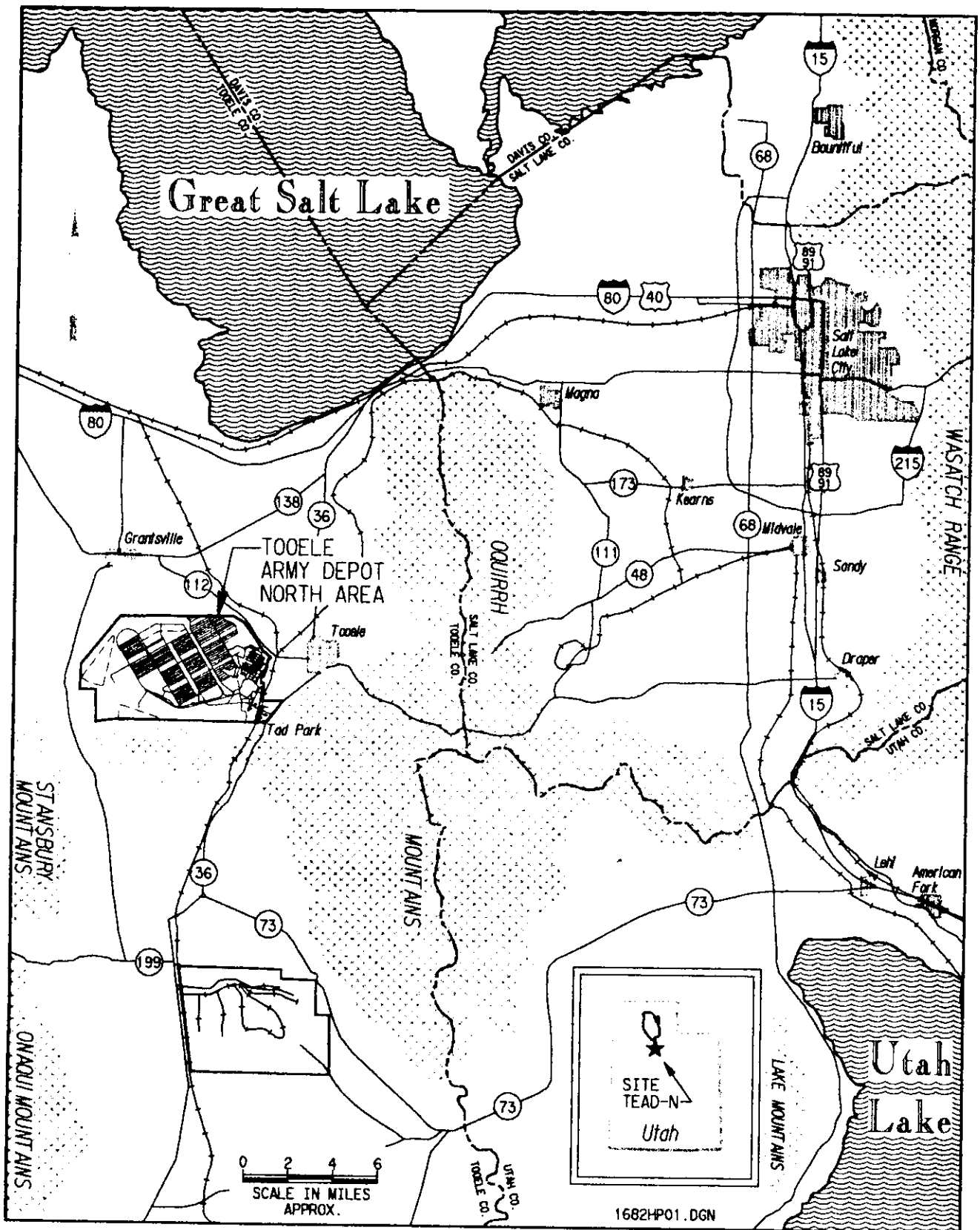


Figure 1-1. Location Map of TEAD-N and Vicinity

mission of TEAD-N is to receive, store, issue, maintain, demilitarize, and dispose of munitions; to overhaul and maintain equipment; to provide installation support to attached organizations; and to operate other facilities as assigned. Its major functions include the following:

- Supply, distribute, and store general supplies and ammunition.
- Store strategic and critical materials.
- Survey and maintain ammunition and general supplies.
- Demilitarize ammunition.
- Supervise training of assigned units and provision of logistical support and training assistance to U.S. Army Reserve Component units.
- Design, manufacture, procure, store, and test ammunition handling and maintenance equipment.
- Repair, maintain, and store military vehicles and equipment.

During World War II, Tooele Army Depot (TEAD) was a back-up depot for the Stockton Ordnance Depot and Benicia Arsenal, both located in California. It stored vehicles, small arms, and other equipment for export.

Due to continuous operations at TEAD-N since 1942, numerous sources and potential sources of hazardous or potentially hazardous waste have been identified. Previous environmental investigations have resulted in the identification of 47 Sites/SWMUs, covering a broad range of operations and activities (see Table 1-1). For the purpose of the BRA, Sites/SWMUs in the eastern industrially developed portion of TEAD-N have been grouped together. They are collectively referred to as the Industrial Area and include Sites/SWMUs 12, 14, 15, 17, 29, 30, and 32. Sites/SWMUs 1, 2, 3, 7 and 10/11 are each evaluated on an individual basis.

## 1.5 SCOPE OF RISK EVALUATION

The PBRA is based on the data available for 46 sites and SWMUs, numbered 1 to 47, at TEAD-N (see Figure 1-2). (Site 16 no longer exists; however, the sites and SWMUs have not been renumbered.) The RI/FS and RFI field studies are scheduled to begin in the spring of 1992. The PBRA will be updated as necessary following the field investigation and incorporated as an in-depth BRA in both the RI/FS report and the Phase II RFI report. The PBRA serves as a means of identifying potential health effects based on current worst-case scenarios of the site and allows decisions to be made regarding proposed field activities.

The purpose of this PBRA is to estimate potential risk to receptors under current or baseline and future land-use conditions. A fate and transport model was developed for each identified disposal site or combination of sites with useable chemical data. Exposure-point concentrations at receptors were predicted for the volatile and nonvolatile organics and metals found in the soil and groundwater. The receptor locations in the air-transport model were on-site at TEAD-N and at the closest boundaries of the communities of Grantsville, Tooele, and Stockton, Utah. Groundwater contaminants were modeled to the closest domestic-water wells downgradient from the source. In addition, a site-wide conceptual

*Table 1-1. Solid Waste Management Units and Sites at TEAD-N*

Site/SWMU No.	Site Name
1	Open Burning/Open Detonation (OB/OD) Areas
2	Industrial Wastewater Lagoon (IWL)
3	X-Ray Lagoon
4	Sandblast Facility
5	Pole Transformer PCB Spill
6	Old Burn Area
7	Chemical Range
8	Small Arms Firing Range
9	Drummed Radioactive Waste Storage Area
10,11	TNT Washout Facility
12,15	Sanitary Landfill
13	Tire Disposal Site
14	Sewage Lagoons
17	Former Transformer Storage Area
18	Radioactive Waste Storage Building S-659
19	Ammunition Equipment Directorate (AED) Demilitarization Test Facility
20	AED Deactivation Furnace Site
21	Deactivation Furnace Building 1320
22	Building 1303 Washout Pond
23	Bomb and Shell Reconditioning Building
24	Battery Pit
25	Battery Shop
26	Defense Reutilization and Marketing Office (DRMO) Storage Yard
27	RCRA Container Storage Area
28	90-Day Drum Storage Area
29	Drum Storage Areas
30	Old IWL
31	Former Transformer Boxing Site
32	PCB Spill Site
33	PCB Storage Building 659
34	Pesticide/Herbicide Storage Building
35	Wastewater Spreading Area
36	Old Burn Staging Area
37	Contaminated Waste Processor (CWP)
38	Industrial Wastewater Treatment Plant (IWTP)
39	Solvent Recovery Facility
40	AED Test Range
41	Box Elder Wash Drum Site
42	Building 539 Retort Furnace
43	Container Storage Area for P999



*Table 1-1. Solid Waste Management Units and Sites at TEAD-N (concluded)*

Site/SWMU No.	Site Name
44	Tank Storage of Trichloroethylene
45	Stormwater Discharge
46	Used Oil Dumpsters
47	Boiler Blowdown

model was developed, as appropriate, using the same data. A summary of data by site/SWMU number is provided in Table 1-2.

## **1.6 REPORT ORGANIZATION**

Report organization follows U.S. EPA Risk Assessment Guidance for Superfund, Volume I (USEPA, 1989). Section 2.0, Chemicals of Potential Concern, discusses data collection and evaluation and summarizes the chemicals of potential concern for the sites at TEAD-N. Section 3.0, Exposure Assessment, provides a characterization of the exposure setting and identification of the potentially exposed human and wildlife receptors. Exposure pathways are identified for soil, groundwater, air transport, and exposure-point concentrations as potential receptors are derived. Details of the air and groundwater transport models used to derive estimated exposure-point concentrations are described in Appendices A and B, respectively. Chemical intakes for receptors under current and future land-use scenarios are developed.

Toxicity assessment for the chemicals of potential concern is provided in Section 4.0, and toxicity profiles are presented in Appendix D. Potential risk to receptors under current and future land-use scenarios is characterized by carcinogenic and noncarcinogenic health effects in Section 5.0, Risk Characterization. Potential risks are summarized by pathway, and total risk for each exposure scenario is discussed. Site-wide risks are addressed, as appropriate, based on present understanding of the TEAD-N waste sites.

Uncertainty in each phase of the risk-evaluation process is analyzed in Section 6.0, Uncertainty Analysis. Data needs for the BRA are identified relative to the proposed RI/FS report in Section 7.0, Data Needs (USATHAMA 1992) Section 8.0 is the list of references. Appendix F contains a schedule of field activities to fill many of the data gaps identified in this assessment. Additional data-gap-filling activities are being scheduled for completion during 1992.

The appendices are as follows: Appendix A, Fate and Transport of Volatile Organic Compound Air Emissions; Appendix B, Groundwater Monitoring; Appendix C, Potentially Occurring Plants and Animals; Appendix D, Toxicity Profiles; Appendix E, Proposed and Final MCLs; Appendix F, Schedule of Field Activities to Fill Data Gaps; Appendix G, Potable Well Water Analysis; and Appendix H, Conceptual Site Models.

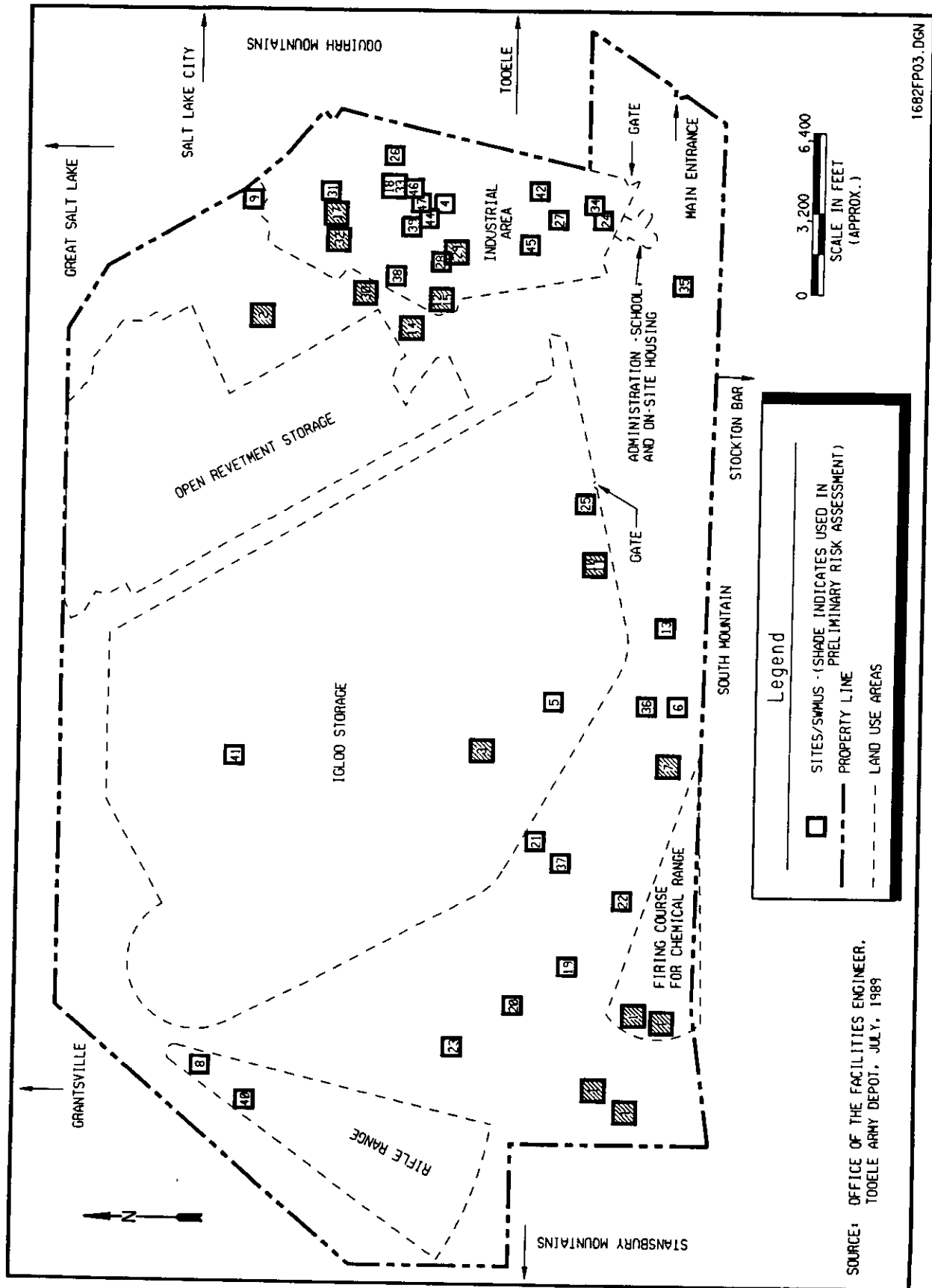


Figure 1-2. Location of TEAD-N Sites/SWMUs

Table 1-2. Available Data by

Site/ SWMU No.	Site Description	Status		
		Included in Site Conceptual Model	Insufficient Data	Potential Contaminants
1	OB/OD	YES		*
2	IWL	YES		*
3	X-Ray Lagoon	YES		*
4	Sandblast Facility		YES	
5	Pole Transformer PCB Spill		YES	
6	Old Burn Area		YES	
7	Chemical Range	YES		*
8	Small Arms Firing Range		YES	
9	Drummed Radioactive Waste Storage Area		YES	
10,11	TNT Washout Facility	YES		*
12,15	Sanitary Landfill	YES		*
13	Tire Disposal Site		YES	
14	Sewage Lagoons	YES		*
17	Former Transformer Storage Area	YES		*
18	Radioactive Waste Storage Building		YES	
19	AED Demil Test Facility		YES	
20	AED Deactivation Furnace Site		YES	
21	Deactivation Furnace Building 1320		YES	
22	Building 13C3 Washout Pond		YES	
23	Bomb and Shell Reconditioning Bldg		YES	
24	Battery Pit		YES	
25	Battery Shop		YES	

Table 1-2. Available Data by Site/SWMU (continued)

Site/ SWMU No.	Site Description	Status		
		Included in Site Conceptual Model	Insufficient Data	Potential Contaminants
26	DRMO		YES	
27	RCRA Container Storage Area		YES	
28	90-Day Drum Storage Area		YES	
29	Drum Storage Areas	YES		*
30	Old IWL	YES		*
31	Former Transformer Boxing Site		YES	
32	PCB Spill Site	YES		*
33	PCB Storage Building 659		YES	
34	Pesticide/Herbicide Storage Bldg		YES	
35	Wastewater Spreading Area		YES	
36	Old Burn Staging Area		YES	
37	CWP		YES	
38	IWTP		YES	
39	Solvent Recovery Facility		YES	
40	AED Test Range		YES	
41	Box Elder Wash Drum Site		YES	
42	Building 539 Retort Furnace		YES	
43	Container Storage Area for P999		YES	
44	Tank Storage of TCE		YES	
45	Storm water Discharge		YES	
46	Used Oil Dumpsters		YES	
47	Boiler Blow Down		YES	

\*See Section 2.0 for specific sites/media.

## **2.0 CHEMICALS OF POTENTIAL CONCERN**

### **2.1 DATA COLLECTION**

The data used in this PBRA were derived from two primary sources: (1) the Site Investigation and Follow-On Remedial Investigation, Final Site Investigation Work Plan (USATHAMA 1990a) and (2) the Remedial Investigation/Feasibility Studies, Final Work Plan (USATHAMA 1992). The locations of waste sites, where additional soil samples are being collected as of the date of this report, are shown in Figure 2-1, and Table 1-1 shows a list of all sites and SWMUs by number and name. Existing monitoring wells and water-supply wells are shown in Figure 2-2. Downgradient off-site wells were considered potential exposure points for groundwater, as shown in Figure 2-3.

Analytical methods are provided in the Quality Assurance/Quality Control (QA/QC) Plan for the TEAD RI (Weston 1989). Analytical data were generated by USATHAMA-certified laboratories using USATHAMA-certified procedures (USATHAMA 1990b). The validated data reported in the Final Site Investigation Work Plan and Final Work Plan (USATHAMA 1990a and 1992) were used as the starting point for this evaluation. Detection limits are provided in Appendix I.

Additional data collection activities are ongoing or scheduled (see Appendix F). In addition to the activities presented in Appendix F, other field activities and data acquisitions are being carried out at TEAD-N in order to develop a comprehensive data base for the final BRA.

### **2.2 DATA EVALUATION**

For soils data, all chemicals for which concentrations were below detection limits or results were reported as non-detect (ND) were eliminated from the surface-soil-data set. Inorganic chemicals detected were compared to background levels compiled by the U.S. Geological Survey from Tooele County at two locations north of TEAD-N near Interstate 80. These background soils data indicated low levels of arsenic, chromium, copper, mercury, sodium, nickel, lead, selenium, and fluoride. Chemical concentrations below background were eliminated from the data set. For remaining chemicals in soils, the maximum reported concentrations were used when more than one value was reported at a given site for a given chemical. At Site 2 and the Industrial Area, sufficient data were available to calculate average concentrations for chemicals detected in soil. Surface soils data were available for Sites/SWMUs 1, 3, 7, 10/11, 17, 29, and 32.

Current activities at TEAD-N include development of site-specific background data to be used in the BRA.

A total of 24 groundwater wells were used for data analyses from the TEAD-N site for purposes of this preliminary report. Monitoring wells were selected based upon the waste site with which they were affiliated. For groundwater data, all chemicals for which concentrations were reported below the detection limit or ND were eliminated from the data set of wells selected as representative for each site. Since inadequate groundwater-

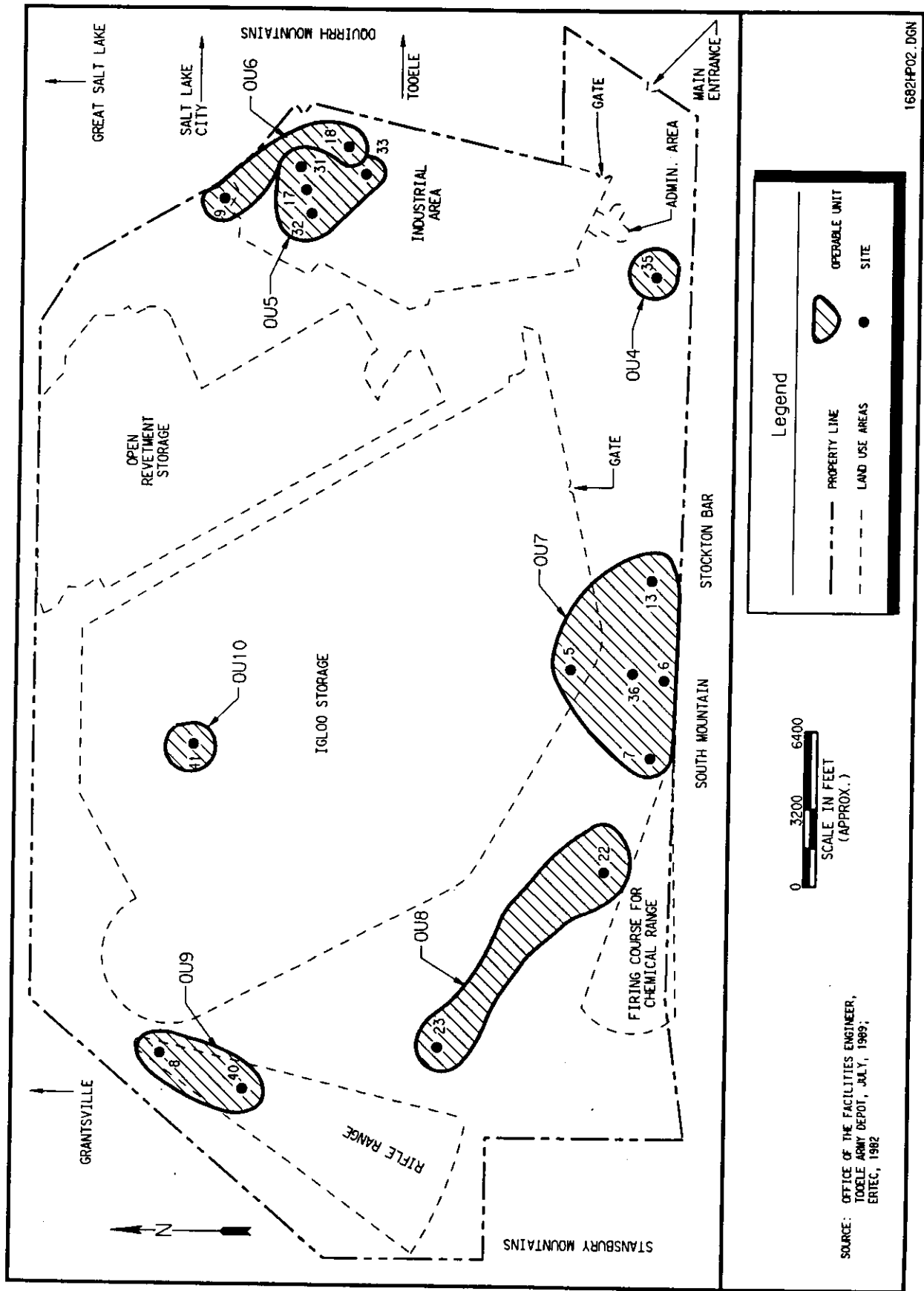


Figure 2-1. Location Map of Collected Soil Samples

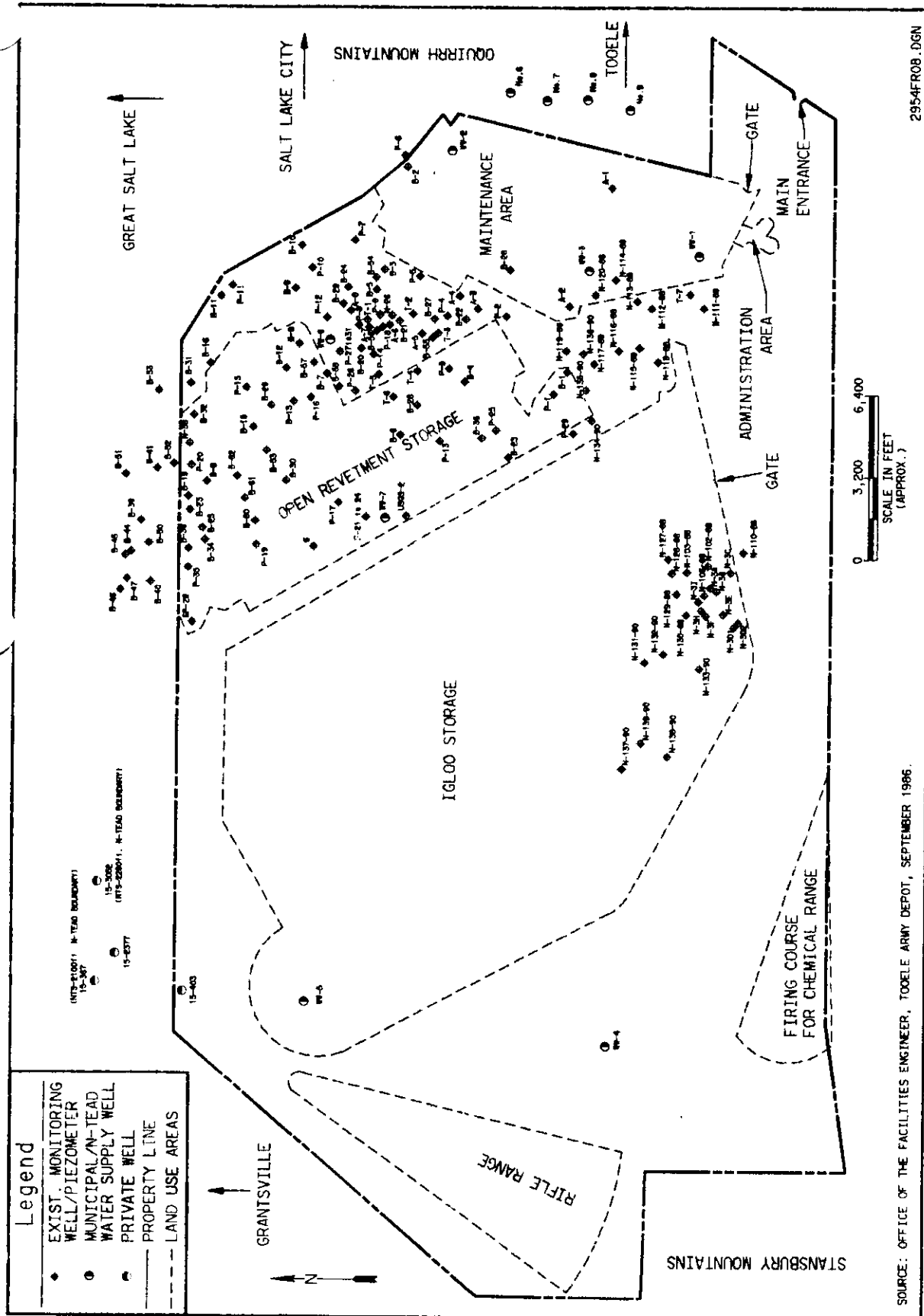


Figure 2-2. Location Map of Existing Wells and Piezometers

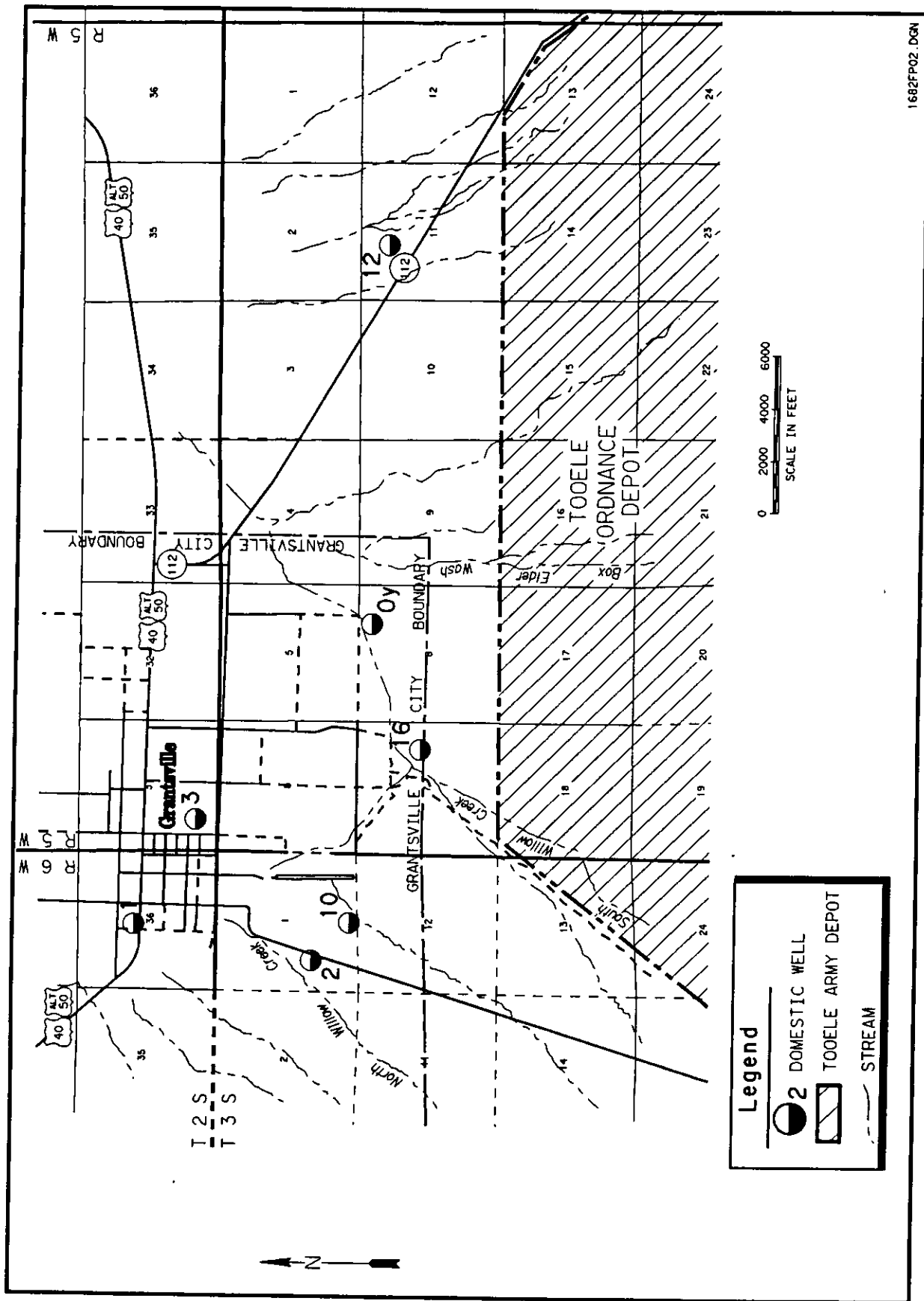


Figure 2-3. Location Map of Existing Domestic Wells



background samples were available for comparison purposes, data were evaluated by selecting the highest concentration available from within the data set, if more than one concentration was available. At Site 2 and the Industrial Area, sufficient data were available to calculate average concentration of chemicals detected in groundwater. RI data are currently being collected. These data will be updated and presented in the RI report risk assessment for the CERCLA sites.

For off-site residential modeling of groundwater at each of the sites, the maximum value for each chemical at a site was compared with Maximum Contamination Levels (MCLs) and Utah Groundwater Water Quality Standards. If a chemical-constituent-concentration value was below either the MCL or Utah Groundwater Water Quality Standard, then it was not modeled.

Chemicals detected and their respective concentrations in soil and groundwater are summarized in Tables 2-1 and 2-2. The chemicals identified as being of potential concern for each site are marked with an asterisk.

## **2.2.1 Site/SWMU 1**

### **2.2.1.1 *Soil***

Maximum concentrations of each chemical detected in surface soil at the site/SWMU were compared to known background levels (USATHAMA 1990). Several metals were eliminated as potential chemicals of concern because they were detected at levels below background. These metals were arsenic, chromium, and mercury.

### **2.2.1.2 *Groundwater***

Two water supply wells, WW-4 and WW-5, were considered representative of Site/SWMU 1, since no monitoring wells were identified closer to the site/SWMU. The potential chemicals of concern for this site include five metals and nitrate. No organics were selected.

## **2.2.2 Site/SWMU 2**

### **2.2.2.1 *Soil***

All chemicals detected in surface soil were above background levels prior to remediation. This site/SWMU has been capped.

Table 2-1. Chemicals Detected in Surface Soils (mg/kg)

Constituent	Site/SWMU							Back-Ground
	✓ 1	3	✓ 7	10,11	✓ 17	✓ 29	32	
Arsenic	0.67	ND <sup>(a)</sup>	ND	ND	NA <sup>(b)</sup>	ND	NA	48
Barium	30.7*	ND	NA	39.8*	NA	ND	NA	ND
Beryllium	ND	NA	0.51*	ND	NA	ND	NA	ND
Cadmium	0.7*	ND	3.2*	ND	NA	3.3*	NA	ND
Chromium	2.5	30.7*	21.8	15	NA	33.2*	NA	30
Copper	ND	NA	22.8	4	NA	28.2	NA	100
Fluoride	NA	NA	6.5*	ND	NA	NA	NA	NA
Lead	36.3	ND	37.1	2.4	NA	37.2	NA	70
Mercury	0.0008	ND	ND	ND	NA	ND	NA	0.09
Nickel	ND	NA	26.9*	5.1	NA	81*	NA	15
Nitrate/Nitrite	NA	NA	ND	60.8*	NA	NA	NA	NA
Silver	ND	ND	ND	0.02*	NA	ND	NA	ND
Zinc	ND	NA	2000*	16.2	NA	1030*	NA	80
Anthracene	NA	NA	ND	ND	NA	ND	NA	NA
Benzo(a)anthracene	NA	NA	ND	ND	NA	0.5*	NA	NA
Benzo(k)fluoranthene	NA	NA	ND	ND	NA	0.6*	NA	NA
Benzo(a)pyrene	NA	NA	ND	ND	NA	0.66*	NA	NA
Bis(2-ethylhexyl)phthalate	NA	NA	ND	ND	NA	ND	NA	NA
Carbon tetrachloride	NA	NA	ND	ND	NA	ND	NA	NA
Chrysene	NA	NA	ND	ND	NA	1.65*	NA	NA
cis-1,2-dichlorobenzene	NA	NA	ND	ND	NA	ND	NA	NA
Dibutyl-phthalate	NA	NA	ND	ND	NA	ND	NA	NA
1,2-Dichlorobenzene	NA	NA	ND	ND	NA	ND	NA	NA
1,3-Dichlorobenzene	NA	NA	NA	NA	NA	ND	NA	NA
1,4-Dichlorobenzene	NA	NA	NA	NA	NA	ND	NA	NA
1,1-Dichloroethane	NA	NA	NA	NA	NA	ND	NA	NA
2,4-Dimethylphenol	NA	NA	NA	NA	NA	ND	NA	NA

Table 2-1. Chemicals Detected in Surface Soils (mg/kg) (continued)

Constituent	Site/SWMU							Back-Ground
	✓ 1	3	7	10,11	17	29	✓ 32	
2,4-Dinitrotoluene	1.2*	NA	ND	8.2*	NA	NA	NA	NA
2,6-Dinitrotoluene	1*	NA	ND	ND	NA	NA	NA	NA
2,4,6-trinitrotoluene	52*	NA	ND	20733*	NA	NA	NA	NA
Ethylbenzene	NA	NA	NA	NA	NA	ND	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	0.61*	NA	NA
HMX	13*	NA	ND	95.2*	NA	NA	NA	NA
Naphthalene	NA	NA	NA	NA	NA	ND	NA	NA
Phenanthrene	NA	NA	NA	NA	NA	28*	NA	NA
PCB 1262	NA	NA	NA	NA	0.108*	NA	0.214*	NA
Pyrene	NA	NA	NA	NA	NA	5.4*	NA	NA
Tetrachloroethylene	NA	NA	NA	NA	NA	ND	NA	NA
Trichloroethane	NA	NA	NA	NA	NA	ND	NA	NA
Trichloroethylene	NA	NA	NA	NA	NA	5.63*	NA	NA
1,3,5-Trinitrobenzene	ND	NA	ND	47*	NA	NA	NA	NA
Toluene	NA	NA	NA	NA	NA	ND	NA	NA
m-Xylene	NA	NA	NA	NA	NA	ND	NA	NA
o-Xylene	NA	NA	NA	NA	NA	ND	NA	NA
p-Xylene	NA	NA	NA	NA	NA	ND	NA	NA

\* Chemicals of potential concern.

1 Values represent maximum concentrations; sample depth surface to 2 ft.

\*ND = Not detected.

\*NA = Not analyzed.

Table 2-2. Chemicals Detected in Groundwater

Constituent	Maximum Concentration (ug/l) by Site/SWMU						
	MCL	1	2	10/11	12,14,15	29	30
<b><u>INORGANICS</u></b>							
Arsenic	50	ND <sup>(a)</sup>	5.0*	110*	22.0*	7.0*	3.0*
Barium	1,000	133*	NA <sup>(b)</sup>	94.0*	NA	1.6*	NA
Beryllium	4	NA	NA	ND	0.4*	1.6*	NA
Cadmium	5	120*	12.0*	ND	15.0*	ND	ND
Chromium	100	18.0*	40.0*	15.0*	720*	5.0*	ND
Copper		ND	16.0*	33.0*	37.7*	220*	ND
Fluoride	4,000	NA	NA	6,640*	1.06*	ND	NA
Iron		NA	1,600*	NA	1,200*	NA	ND
Lead	50	ND	8.0*	46.0*	37.4*	45.1*	ND
Manganese		NA	5,400*	NA	87.0*	NA	ND
Nickel	100	ND	NA	33.0*	58.3*	294*	NA
Nitrate	10,000	17,500*	ND	264,000*	8.0*	10.0*	ND
Sodium		36,000*	NA	296,000*	196*	NA	NA
Silver	50	ND	ND	0.6*	8.0*	2.5*	ND
Thallium	2	ND	NA	3.4*	NA	NA	NA
Zinc		300*	880*	90.0*	1,900*	470*	ND
<b><u>ORGANICS</u></b>							
Benzene	5	NA	ND	NA	0.8*	NA	ND
Benzyl Alcohol		NA	NA	8.0*	NA	NA	NA
Bis(2-ethylhexyl)phthalate		NA	NA	10.0*	ND	790*	NA
Carbon tetrachloride	5	NA	20.0*	NA	20*	NA	41.0*
Chloroform	100 <sup>2</sup>	NA	ND	2.0*	4.2*	NA	5.0*
Cycloalkanes		NA	NA	NA	60.0*	NA	NA
Cyclonite (RDX)		ND	NA	160*	8.5*	NA	NA
1,2-Dichlorobenzene	600	NA	0.8*	NA	ND	NA	ND
1,3-Dichlorobenzene		NA	0.2*	NA	ND	NA	ND

Table 2-2. Chemicals Detected in Groundwater (continued)

Constituent	Maximum Concentration (ug/l) by Site/SWMU						
	MCL	1	2	10/11	12,14,15	29	30
1,4-Dichlorobenzene	75	NA	0.4*	NA	ND	NA	ND
1,1-Dichloroethane		NA	150*	NA	ND	NA	ND
1,1-Dichloroethylene	7	NA	2.9*	NA	4.2*	NA	5.0*
trans-1,2-Dichloroethylene	100	NA	NA	NA	2.6*	NA	NA
2,4-Dinitrotoluene		NA	NA	20.0*	NA	NA	NA
Ethylbenzene	700	NA	0.6*	NA	ND	NA	ND
HMX		NA	NA	17.6*	NA	NA	NA
2-Methyl-4,6-Dinitrophenol		NA	NA	27.0*	NA	NA	NA
Phenol		NA	NA	3.0*	NA	NA	NA
Tetrachloroethylene	5	NA	0.3*	NA	ND	NA	ND
Toluene	1,000	NA	1.2*	6.0*	5.0*	NA	ND
1,1,1-Trichloroethane	200	NA	200*	1.8*	NA	NA	5.0*
Trichloroethylene	5	ND	250*	NA	47.6*	1.11*	140*
1,3,5-Trinitrobenzene		NA	NA	100*	NA	NA	NA
2,4,6-Trinitrotoluene		NA	NA	37.4*	NA	NA	NA
m,p-Xylenes	10,000 <sup>2</sup>	NA	3.8*	NA	NA	NA	ND
o-Xylenes	10,000 <sup>2</sup>	NA	1.0*	NA	1.5*	NA	ND

\*NA = Not analyzed.

<sup>b</sup>ND = None detected.

\*Chemical of potential concern.

#### **2.2.2.2 *Groundwater***

Data from monitoring wells B5, T1, and N26 were evaluated as representative of Sites/SWMU 2. Chemicals of potential concern for this site include 8 metals and 13 organics.

#### **2.2.3 Site/SWMU 3**

##### **2.2.3.1 *Soil***

Only one chemical, chromium, was detected in surface soil. It was above background level and, therefore, selected as a chemical of potential concern.

##### **2.2.3.2 *Groundwater***

Groundwater data were not available for this site.

#### **2.2.4 Site/SWMU 7**

##### **2.2.4.1 *Soil***

Maximum concentrations of each chemical detected in surface soil at the site were compared to background levels. Chromium, copper, and lead were eliminated as chemicals of potential concern because they were detected at levels below background.

##### **2.2.4.2 *Groundwater***

Groundwater data were not available for this site.

#### **2.2.5 Sites/SWMUs 10/11**

##### **2.2.5.1 *Soil***

Maximum concentrations of each chemical detected in surface soil at the site were compared to known background levels. Several metals were eliminated as chemicals of potential concern because they were detected at levels below background. These metals were chromium, copper, nickel, lead, and zinc.

#### **2.2.5.2 Groundwater**

Data from five monitoring wells —N-3A, N-3H, N-3B, N-3F, and N-3I— were evaluated for this site. Nitrate, 11 metals, and 12 organics were selected as chemicals of potential concern.

#### **2.2.6 Sites/SWMUs 12/14/15**

##### **2.2.6.1 Soil**

No soil data were available for this site grouping.

##### **2.2.6.2 Groundwater**

Twelve monitoring wells were evaluated as representative of this site. The wells were A2, B1, T7, N-111-88, N-113-88, and N-115-88 through N-120-88. Thirteen metals and ten organics represent the chemicals of concern. Well N-113-88, approximately 50 feet in depth, was abandoned and grouted after completion and, therefore, is no longer included in the monitoring program.

#### **2.2.7 Site/SWMU 17**

##### **2.2.7.1 Soil**

PCB 1262 was the only chemical detected in surface soil.

##### **2.2.7.2 Groundwater**

Groundwater data were not available for this site.

#### **2.2.8 Site/SWMU 29**

##### **2.2.8.1 Soil**

Maximum concentrations of each chemical detected in surface soil at the site were compared to background levels. Arsenic and copper were eliminated as potential chemicals of concern because they were detected at levels below background.

#### **2.2.8.2 Groundwater**

Two monitoring wells, N-112-88 and N-114-88, were chosen as representative of this site. Nine metals, nitrate, and two organics were chosen as chemicals of potential concern.

#### **2.2.9 Site/SWMU 30**

##### **2.2.9.1 Soil**

Soil data were not available for this site.

##### **2.2.9.2 Groundwater**

One monitoring well, B-27, was chosen as representative of this site. One metal and five organics were chosen as chemicals of potential concern.

#### **2.2.10 Site/SWMU 32**

##### **2.2.10.1 Soil**

PCB 1262 was the only chemical detected in surface soil.

##### **2.2.10.2 Groundwater**

Groundwater data were not available for this site.

### **2.3 SUMMARY OF CHEMICALS OF POTENTIAL CONCERN**

Chemicals of potential concern for the risk evaluation are summarized in Table 2-3. Twenty-three chemicals were identified for surface soils. Forty-three chemicals of potential concern were selected for groundwater. There were 18 VOCs of concern for the air media. PCB 1262 was only detected in surface soils. Chemicals of concern only in groundwater were arsenic; copper; iron; manganese; sodium; lead; thallium; benzyl alcohol; chloroform; benzene; cyclonite (RDX); bis-(2-ethylhexyl)phthalate; 2-methyl-4,6-dinitrophenol; cycloalkanes; 1,1-, 1,3-, and 1,4-dichlorobenzene; 1,1-dichloroethane; 1,1-dichloroethylene; trans-1,2-dichloroethylene; m-, o-, and p-xylene; and phenol. Chemicals of potential concern in all three media were 2,4-dinitrotoluene; 2,4,6-trinitrotoluene; ethylbenzene; HMX; tetrachloroethylene; trichloroethylene; and 1,3,5-trinitrobenzene.



Table 2-3. Summary of Chemicals of Potential Concern

Chemical	Surface Soil	Ground Water	Air
Arsenic		X	
Barium	X	X	
Beryllium	X	X	
Cadmium	X	X	
Chromium	X	X	
Copper		X	
Fluoride	X	X	
Iron		X	
Lead		X	
Manganese		X	
Nickel	X	X	
Nitrate/Nitrite	X	X	
Silver	X	X	
Sodium		X	
Thallium		X	
Zinc	X	X	
Benzene		X	
Benzo(a)anthracene	X		X
Benzo(k)fluoranthene	X		X
Benzo(a)pyrene	X		X
Benzyl Alcohol		X	
Bis(2-ethylhexyl)phthalate		X	
Carbon tetrachloride		X	X
Chloroform		X	
Chrysene	X		X
Cis-1,2-dichloroethene			
Cycloalkanes		X	
Cyclonite (RDX)		X	

Table 2-3. Summary of Chemicals of Potential Concern (continued)

Chemical	Surface Soil	Ground Water	Air
1,2-Dichlorobenzene		X	
1,3-Dichlorobenzene		X	
1,4-Dichlorobenzene		X	
1,1-Dichloroethane		X	
1,1-Dichloroethylene		X	
trans-1,2-Dichloroethylene		X	
2,4-Dinitrotoluene	X	X	X
2,6-Dinitrotoluene	X		X
Ethylbenzene		X	X
Fluoranthene	X		X
HMX	X	X	X
2-methyl-4,6-dinitrophenol		X	
Naphthalene			
Phenanthrene	X		X
Phenol		X	
PCB 1262	X		
Pyrene	X		X
Tetrachloroethylene		X	X
Toluene		X	X
1,1,1-Trichloroethane		X	X
Trichloroethylene	X	X	X
1,3,5-Trinitrobenzene	X	X	X
2,4,6-Trinitrotoluene	X	X	X
m-Xylenes		X	
o-Xylenes		X	
p-Xylenes		X	

## 2.4

## UNCERTAINTY

Several sources of uncertainty exist with regard to surface-soil data. One is the variability of sample types. At Sites/SWMUs 1, 17, and 32, the samples were surface soil. However, at several Sites/SWMUs (2, 3, and 10/11), the samples were dried sediment from chemical lagoons. Samples at 7 were collected only from berms and not from the lower elevations at this site. Depth of sample collection at 29 varied from the surface to 2 feet. Thus, at a number of sites, the sample concentrations were not necessarily characteristic of surface soil.

A second source of uncertainty in the soil data comes from the number of samples collected per site. At Sites/SWMUs 1, 7, 17, 29 and 32, the number of samples were 15, 12, 5, 8, and 5, respectively. Soil data at other Sites/SWMUs (2, 3, 10/11) were single samples. At these sites, the lack of replication, with consequent data on standard error, means that less confidence can be placed in the quality of the values presented. A third source of uncertainty is the lack of background data for some detected chemicals. Background data (USATHAMA 1990) were provided only for the metals arsenic, chromium, copper, lead, mercury, nickel, and zinc. It is quite possible that detected levels of barium, beryllium, and silver would also fall below background levels if these data were available.

Uncertainty in the representativeness of groundwater concentrations arises from the fact that only a single groundwater sample from each well was used. Because many of the sites are in close spatial proximity, groundwater monitored by a single monitoring well may be impacted by more than one site; thus, concentrations modeled may not be truly representative of the single site for which exposure point concentrations were derived. There were no reliable background data for use in evaluating groundwater data, and some detection levels were above the MCL and/or Utah Groundwater Water Quality Standards. Chemicals have not been included as potential chemicals of concern if their detection levels were below MCLs or below Utah Groundwater Quality Standards. Therefore, some of the chemicals of potential concern may have been inappropriately included or excluded in the risk characterization. Some chemicals were not analyzed at all sites.

### **3.0 EXPOSURE ASSESSMENT**

#### **3.1 CHARACTERIZATION OF EXPOSURE SETTING**

TEAD-N's regional physical setting, geology, and hydrology have been documented in previous investigations (USATHAMA 1990a and 1992) and are summarized below.

##### **3.1.1 Physical Setting**

###### **3.1.1.1 *Surface Features***

TEAD-N is located in the southern portion of the Tooele Valley. The north-trending Oquirrh and Stansbury Mountains rise from the valley floor at elevations ranging from 5,000 to over 10,000 feet. Topography of the valley floor is shaped by coalescing alluvial fans formed by erosional debris washed from the mountains. TEAD-N is situated on confluent alluvial fans derived from the Oquirrh Mountains. Alluvial fans that form the valley floor in the vicinity of TEAD-N slope toward the north. TEAD-N topography (see Figure 3-1) is characterized by a gently rolling surface intersected by a series of shallow gullies. The average topographic gradient in the northern portion of the site is approximately 70 feet per mile, increasing to about 150 feet per mile at the southern boundary.

###### **3.1.1.2 *Meteorology***

The climate of the Tooele Valley ranges from arid to semiarid at the salt flats near the Great Salt Lake and in the mountains surrounding the valley. Rainfall is minimal, and the average annual precipitation between 1897 and 1985 was approximately 16.95 inches in Tooele, although in Grantsville the average annual precipitation was 11 inches between 1957 and 1977. The greatest precipitation occurs in the mountains surrounding the valley, where the average amount is more than 40 inches per year. Air temperatures at Tooele from 1941 to 1970 averaged 51 °F (10.6 °C).

###### **3.1.1.3 *Geology***

The Tooele Valley is typical of basin and range physiography in which fault-block mountains arise above flat intermontane valleys. Bedrock in the mountain ranges bordering the valley has been extensively folded and faulted. The Tooele Valley occupies the alluvial plain of the Oquirrh Mountains and is filled with a thick sequence of unconsolidated alluvial sediments of Tertiary and Quaternary age. The valley was formed as sand grains, gravels, and cobbles composed of quartzite, sandstone, and limestone, eroded primarily from the Oquirrh Mountains east of TEAD-N. Because alluvial deposits at TEAD-N generally are coarse grained, they form a productive aquifer system when saturated.

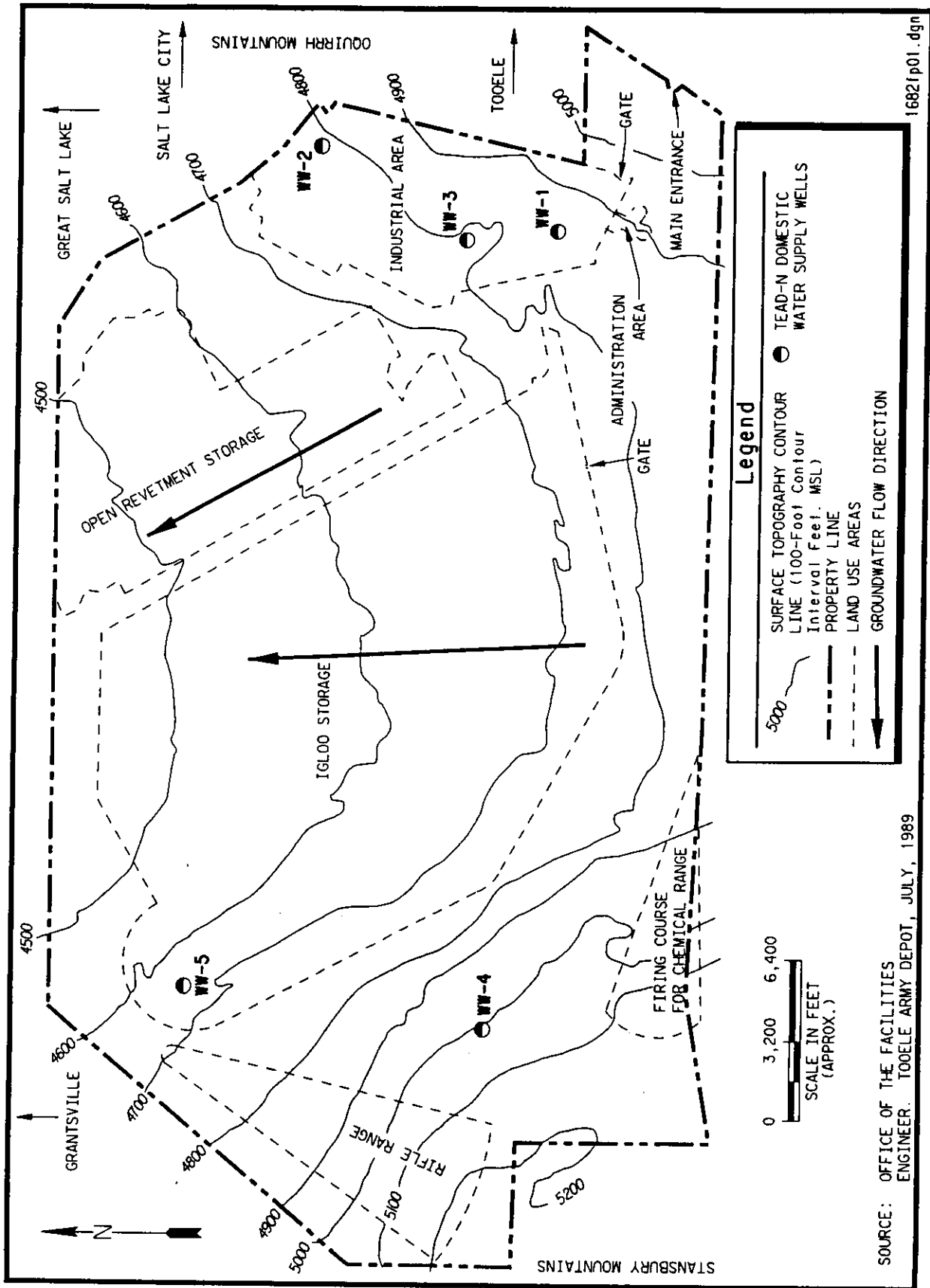


Figure 3-1. TEAD-N Groundwater Flow Direction and Potable Well Locations

Unconsolidated alluvium at TEAD-N is typical of alluvial-fan deposits consisting of poorly sorted clayey silty sand, gravel, and cobbles. Alluvium samples are typically yellowish brown to grayish orange, with varying amounts of pink, red, black, yellow, and orange quartzite fragments and/or dark gray limestone. Fine-grained layers have been observed and have been estimated to range from less than 10 to more than 70 feet thick. Bedrock beneath the unconsolidated sediment of Tooele Valley consists of alternating quartzite and limestone beds similar to late Paleozoic rocks. The most significant bedrock features are a series of limestone and quartzite bedrock outcrops located approximately 1,000 feet north of the IWL area. Depths to bedrock range from zero at surface outcrops in the northeast corner of TEAD-N to more than 2,000 feet below ground surface in the south-central portion of the facility. Bedrock throughout TEAD-N consists of fine-grained, blue-gray, and black limestone with calcite-filled veins and white, red, and brown fine-grained-to-granular quartzite.

#### **3.1.1.4 Soils**

Soil types across TEAD-N are variable consisting of Abela, Berent-Hilo Peak, Bindow and Doyce mapping units. Soil types at waste sites are summarized in Table 3-1. With the exception of the Doyce unit, which has a slow to moderately slow permeability with an infiltration rate of  $1.4 \times 10^{-4}$  to  $1.4 \times 10^{-3}$  centimeters per second (cm/sec), the permeability of these soils is moderate to rapid with infiltration rates of  $4.2 \times 10^{-4}$  to  $1.4 \times 10^{-2}$  cm/sec.

#### **3.1.1.5 Hydrogeology**

Groundwater in Tooele Valley is found in the alluvial valley fill deposits and, to a lesser extent, in underlying bedrock. The alluvial aquifer is composed primarily of gravels, with major imbedded zones composed of varying amounts of sands, silts, and clays. Average calculated vertical groundwater-seepage rates range from less than 1 foot per year to 200 feet per year. Groundwater flow direction at TEAD-N is from the southeast to the northwest, but is altered somewhat in the IWL Area where the alluvial aquifer encounters the fault-block bedrock ridge. The potentiometric surface is relatively flat with a hydraulic gradient of approximately 0.007 foot per foot across the installation.

The bedrock aquifer consists primarily of low permeability quartzite and limestone, and occurs beneath the relatively small area in the eastern portion of TEAD-N. The remainder of TEAD-N and the Tooele Valley is directly underlain by the alluvial aquifer. Although permeability of the bedrock is low, extensive fracturing in the bedrock allows for considerable groundwater flow.

Previous reports also show localized moist zones at depths of 17 to 180 feet beneath the TNT Washout Facility (Sites/SWMUs 10/11) and the Sanitary Landfill (Sites/SWMUs 12/15) at TEAD-N. The varied depths of these zones indicate that numerous, localized moist zones exist on the installation. Other reports also indicate that groundwater perched along these zones will eventually reach the regional alluvial aquifer.

*Table 3-1. Soils Classification at Waste Sites/SWMUs*

Site/ SWMU No.	Site Name (1-42)	Soil Type
1	Open Burning/Open Detonation (OB/OD) Areas	Hiko Peak gravelly loam, Medburn fine sandy loam, Birdow loam, Berent loamy fine sand
2	Industrial Wastewater Lagoon (IWL)	Abela gravelly loam, Manassa loam
3	X-ray Lagoon	Berent loamy fine sand, Medburn fine sandy loam
4	Sandblast Facility	Abela gravelly loam
5	Pole Transformer PCB Spill	Berent loamy fine sand
6	Old Burn Area	Abela gravelly loam
7	Chemical Range	Abela gravelly loam
8	Small Arms Firing Range	Hiko Peak gravelly loam, Taylorsflat loam
9	Drummed Radioactive Waste Storage Area	Abela gravelly loam
10, 11	TNT Washout Facility	Berent loamy fine sand
12, 15	Sanitary Landfill	Abela gravelly loam
13	Tire Disposal Site	Hiko Peak gravelly loam, Abela gravelly loam
14	Sewage Lagoons	Abela gravelly loam, Medburn fine sandy loam
17	Former Transformer Storage Area	Abela gravelly loam
18	Radioactive Waste Storage Building S-659	Abela gravelly loam
19	Ammunition Equipment Directorate (AED) Demilitarization Test Facility	Berent loamy fine sand, Hiko Peak gravelly loam
20	AED Deactivation Furnace Site	Hiko Peak gravelly loam
21	Deactivation Furnace Building 1320	Berent loamy fine sand, Medburn fine sandy loam
22	Building 1303 Washout Pond	Abela gravelly loam, Hiko Peak gravelly loam, Berent loamy fine sand
23	Bomb and Shell Reconditioning Building	Hiko Peak gravelly loam, Berent loamy fine sand

*Table 3-1. Soils Classification at Waste Sites/SWMUs (continued)*

Site/ SWMU No.	Site Name (1-42)	Soil Type
24	Battery Pit	Doyce Loam, Abela gravelly loam
25	Battery Shop	Berent loamy fine sand
26	Defense Reutilization and Marketing Office (DRMO) Storage yard	Abela gravelly loam
27	RCRA Container Storage Area	Abela gravelly loam
28	90-Day Drum Storage Area	Abela gravelly loam
29	Drum Storage Areas	Abela gravelly loam
30	Old IWL	Medburn fine sandy loam, Abela gravelly loam
31	Former Transformer Boxing Site	Abela gravelly loam
32	PCB Spill Site	Abela gravelly loam
33	PCB Storage Building 659	Abela gravelly loam
34	Pesticide/Herbicide Storage Building	Doyce Loam, Abela gravelly loam
35	Wastewater Spreading Area	Doyce Loam, Abela gravelly loam
36	Old Burn Staging Area	Abela gravelly loam
37	Contaminated Waste Processor (CWP)	Medburn fine sandy loam
38	Industrial Wastewater Treatment Plant (IWTP)	Medburn fine sandy loam, Abela gravelly loam
39	Solvent Recovery Facility	Abela gravelly loam
40	AED Test Range	Hiko Peak gravelly loam
41	Box Elder Wash Drum Site	Medburn fine sandy loam
42	Building 539	Abela gravelly loam



#### **3.1.1.6 Surface Water**

During rare periods of heavy rain or rapid melting of mountain snowpacks, surface water may occur at TEAD-N in Box Elder Wash and South Willow Creek, both of which cross the TEAD-N near its western boundaries. See Figure 2-3, which shows the outfall of this creek and wash.

#### **3.1.1.7 Vegetation**

The lack of precipitation, low humidity, extreme air temperature changes, soil types, and light winds typical to the Tooele Valley are significant determinants of vegetation composition. Vegetation at the site is classified as an *Artemisia* Biome, which is characterized by sagebrush (*Artemisia*) and saltbrush. This general classification is broken down into four smaller areas based on predominant vegetation and soil ranges. The Desert Bench Range contains winterfat, budsage, Indian rice grass, and western wheat grass. There are low areas within this range which support greasewood, shadscale, and gray Molly. In areas where puddling occurs, greasewood and inkweed are dominant. The dominant species of the Sandy Hills Range are juniper, low sagebrush, big sagebrush, ephedra, Indian rice grass, sand dropseed, shadscale, and needle and thread grass. In areas not covered by juniper, other vegetation, including big sagebrush, rubber rabbitbrush, and bluebunch wheat grass also occur. The third area, the Foothill Range, contains some of the aforementioned species, but sweet vetch, balsam root, nature blue, and yarrow are also present. In the Upland Loam Range, the dominant species include cheat grass, snakeweed, fesque, big sagebrush, bitter vetch, yellow brush, and paintbrush.

#### **3.1.1.8 Land Use**

Tooele Valley is predominantly undeveloped with the exceptions of Grantsville, Tooele, Stockton, and occasional residential development north of Tooele. Livestock grazing and limited cultivation predominate in the valley. Grantsville is approximately 2 miles north of the northwest corner of TEAD-N; the city of Tooele is east of the installation; and Stockton is located approximately 3 miles south along State Road (SR) 36 (see Figure 1-1).

Except for the city of Tooele, properties immediately adjacent to TEAD-N boundaries are undeveloped. Properties to the north are used for pasture or cultivation; properties to the west and south are used for rangeland grazing. Properties east of TEAD-N consist of Tooele and undeveloped rangeland along the lower western slopes of the Oquirrh Mountains. Scattered gravel pits are also located southeast of the TEAD-N along SR 36. Except for the southeastern portion (bounded by SR 36), TEAD-N is bounded on the east by the Union Pacific Railroad right-of-way. Residential development within Tooele abuts the northern boundary of this portion of TEAD-N. Tooele Municipal Airport and scattered residential homes are located along the eastern boundary north to SR 112, which forms the northeastern boundary of TEAD-N. The area northeast of SR 112 is undeveloped except for a construction company and Tooele Landfill. There is on-base housing for both civilians and

military families in the Administrative Area. Tooele Alternative High School is located in the southeastern corner of TEAD-N.

### **3.1.2 Potentially Exposed Human Populations**

#### **3.1.2.1 *Current Land Use***

Potentially exposed populations on-site under current land use would be workers and security personnel, on-site residents, and students and employees of Tooele Alternative High School. Public access to the facility is controlled, thereby precluding public exposure. On-base housing for both civilians and military families is located on-site in the Administrative Area. There are 30 military personnel and 62 dependents currently living in on-base housing, for a total of 92 people. The average residence time is 1 to 2 years. Tooele Alternative High School is a 4-year technical school. It has 42 full-time and 100 part-time (2 hours/week) students.

The land surrounding TEAD-N is predominantly undeveloped and used for livestock grazing, range land, and limited cultivation. Residential development within the city of Tooele abuts the northern boundary of TEAD-N. Populations potentially exposed to site-related chemicals are residents of the city of Tooele, Stockton (approximately 3 miles to the south), and Grantsville (approximately 2 miles to the north). Potentially sensitive subpopulations in these areas would be children in day-care centers, students in Grantsville and city of Tooele public schools, and patients in hospitals. There are no public schools in Stockton. The number of students enrolled in Grantsville and city of Tooele public schools are 1,530 and 4,088, respectively.

#### **3.1.2.2 *Future Land Use***

On-site land use at TEAD-N could change in the future although it is unlikely. The most likely land use changes at TEAD-N would be additional development or use of some of the study areas by the Army. Development of TEAD-N as a residential area or other public use area is considered highly unlikely given the low-population density and the availability of adjacent, non-Army land for public development. Furthermore, the Army has no current plans to "excess" any land of the TEAD-N and, considering the mission of TEAD-N, it is unlikely that the base would close. However, for this PBRA, residential land use was chosen as an exposure scenario for the western and central portions of the base (Sites/SWMUs 1,2,3,7,10/11) and the eastern portion of the base (Sites/SWMUs 12/14/15,17,29,30,32).

### **3.1.3 Potentially Exposed Wildlife Populations**

Plant, mammal, bird, and reptile species that could potentially live on or near TEAD-N are listed in Appendix C. A search of the U.S. Fish and Wildlife Service data base showed no known occurrences of federal candidate plant species in either unit of TEAD. Potentially occurring mammal species are predominantly small rodents and bats. Some of the smaller

animals are residents while others are temporary visitors to the site. Twenty-five migrant bird species, including the golden and bald eagles, and 41 resident species could occur on TEAD-N. Federal "candidate" species include the ferruginous hawk, peregrine falcon, snowy plover, and long-billed curlew.

Potential risks to wildlife species were not considered in this PBRA. However, the ongoing RI investigation includes collecting data that will be presented in the BRA of the RI report.

### **3.2 EXPOSURE-PATHWAY IDENTIFICATION**

Potential human-exposure pathways for TEAD-N were identified for current and future land use scenarios. A complete pathway includes a chemical source/release, retention or transport medium, exposure point, and route of exposure. Potential human-exposure pathways include:

- Ingestion, dermal contact, and inhalation of sight-related chemicals in groundwater.
- Ingestion, dermal contact, and inhalation of volatile organic chemicals in surface soil and groundwater.

The potential human-exposure pathway for VOCs in soil or groundwater is through inhalation. Permanent surface water is not present on TEAD-N. Conceptual site models are shown in Appendix H.

#### **3.2.1 Current Land Use**

##### **3.2.1.1 Soil**

Under current land use, exposure to soil contaminants can potentially occur through dermal contact, ingestion, and inhalation of particulates. The dermal and ingestion pathways apply to both industrial-worker exposure to chemicals from sites on the eastern third of the base (Sites/SWMUs 2/30, 12/14/15, 17, 29, 32) and the site-specific-worker exposure at sites on the central and western portions of the base (Sites/SWMUs 1, 3, 7, 10/11). Sites/SWMUs 3, 7, 10/11 are inactive and, therefore, not considered under the current on-site exposure scenario. Because of the absence of airborne particulate concentrations, exposure to soil contaminants through inhalation of particulates could not be evaluated. Collection of this data is scheduled and will be included in the BRA.

##### **3.2.1.2 Groundwater**

Exposure to contaminants from groundwater can potentially occur from ingestion, dermal absorption, and inhalation pathways. Ingestion of groundwater can occur through consumption of water from community water wells from Grantsville (Wells 1, 2, and 3) (see Figure 3-2) or from other receptor wells (OY, 10, 12 and 16) downgradient from the site.

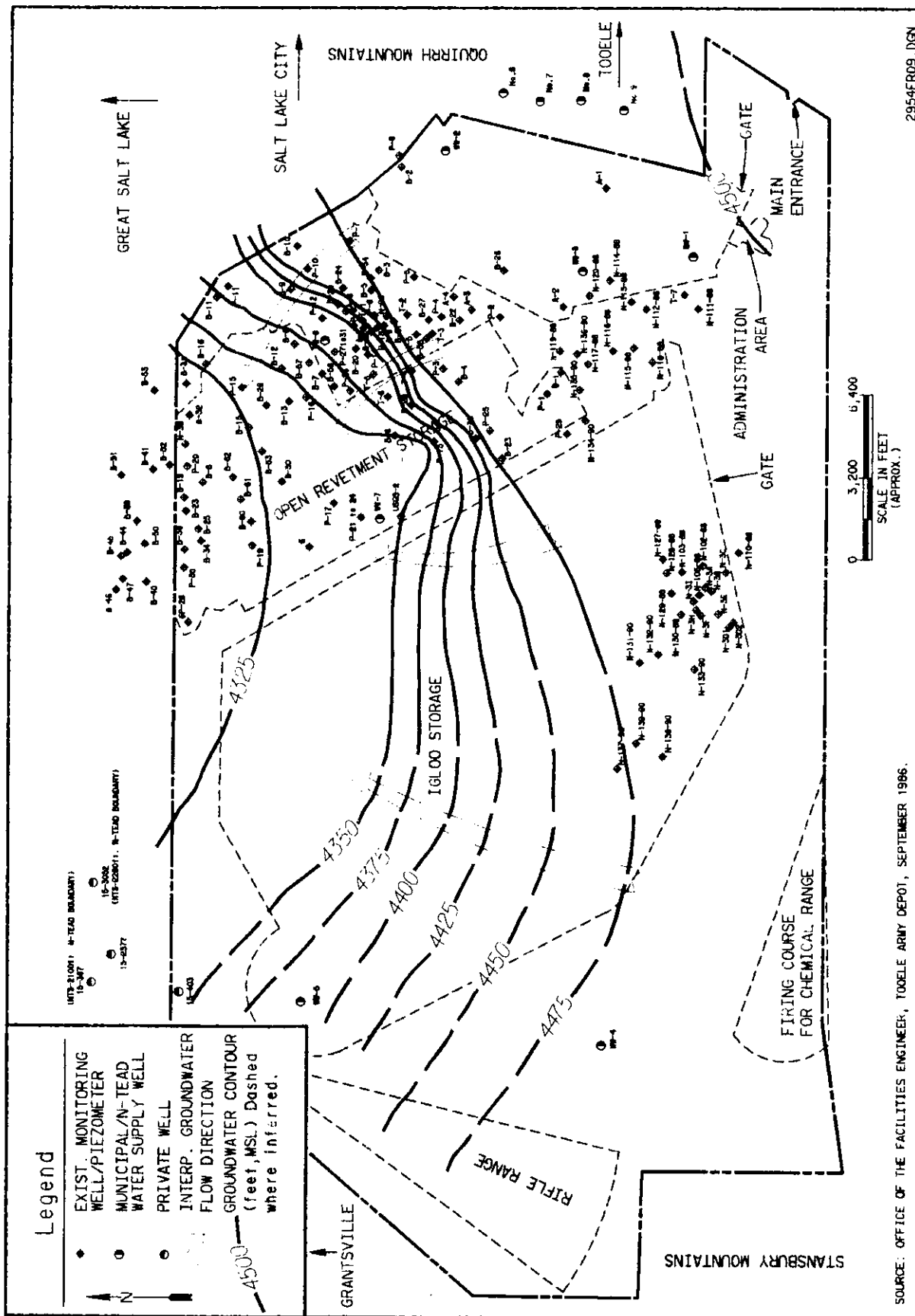


Figure 3-2. Groundwater Flow Direction and Potable Well Locations

The locations of these wells are shown in Figure 2-3. Dermal contact and inhalation of volatiles during showering or bathing are other possible exposure pathways. For this PBRA, it was assumed that the groundwater pathway was complete for off-site receptors at downgradient wells 1, 2, 3, OY, and 12 (see Figure 2-3), although these latter two wells are thought to be used for livestock watering or other non-consumptive uses, and it is uncertain that groundwater plumes from the site reach these wells. Exposure while showering or bathing was not developed in this preliminary screening evaluation, but is planned for collection and evaluation in the BRA.

According to TEAD-N personnel, water supply wells WW-1, WW-2, and WW-3 in the maintenance area of the TEAD-N are currently used to supply water for process and consumptive uses in the maintenance and administrative areas of the depot.

Well WW-4 supplies water in the southwestern portion of TEAD-N for both process and human consumption uses; WW-5 is used intermittently at the firing range, primarily for non-consumptive uses, such as toilets (see Figure 3-2). The water supply system at TEAD-N is an approved public water-supply system regulated by the State of Utah. The system is chlorinated at the well head. Charcoal filters and reverse osmosis units are installed at each water fountain. The system meets State of Utah requirements; therefore, the groundwater pathway for on-site worker exposure is considered incomplete under current use conditions. Results of the most recent monitoring of the water-supply system will be evaluated and discussed as part of the Draft BRA for TEAD-N (see Appendix G).

### **3.2.1.3 Air**

In the current-use scenario, the inhalation pathway is considered for on-site exposure to workers in the industrial area and residents and school facilities in the administrative area; and is considered for off-site exposure to receptors in the communities of Grantsville, Stockton, and the City of Tooele. Air emissions for the pathway to the on-site industrial receptor were modeled based upon surface-soil concentrations of volatiles at Sites/SWMUs 2, 29 and 30. Air emissions for the inhalation pathway for receptors at each of the three neighboring communities were modeled based upon surface-soil concentrations of volatile from all sites at the TEAD-N.

## **3.2.2 Future Land Use**

### **3.2.2.1 Soil**

A future residential scenario is assumed for dermal exposure and ingestion pathways for inside the industrial area and for individual sites outside the industrial area (1, 3, 7, 10/11). Due to a cap at 2, dermal exposure and ingestion pathways are considered to be incomplete at that site. No data are available for airborne particulate concentrations so exposure via this could not be developed for either on-site or off-site receptors. Both dermal exposure and ingestion pathways are considered to be complete for on-site industrial workers.

### **3.2.2.2 Groundwater**

Exposure to groundwater via ingestion, dermal absorption, or inhalation of volatiles can occur for hypothetical on-site residents at Sites/SWMUs 1, 2, 10/11 and in the industrial area, and for residents in neighboring off-site communities. Groundwater may be ingested by residents through drinking water from future on-site wells and from downgradient receptor wells off-site. Exposure from showering or bathing by on-site residents and by residents of neighboring communities was not developed for this PBRA, but will be included in the BRA of the RI report.

On-site industrial-worker exposure to groundwater is considered an incomplete pathway for the future use scenario. For purposes of this PBRA, it is assumed that the water supply from Wells WW-1, WW-2, and WW-3 will continue to undergo chlorination, which is the only treatment prior to use or consumption. Water from the three supply wells is held in a storage tank prior to release into the distribution system. Water-quality analyses for Wells WW-1 and WW-3 and a composite of all three wells indicate that the water supply meets MCLs (see Appendix E).

### **3.2.2.3 Air**

For the future-use scenario, the inhalation pathway is considered to be complete for postulated on-site residents at Sites/SWMUs 1, 10/11, and in the industrial area at locations where volatiles were detected in surface soils. The inhalation pathway for industrial workers in the future scenario is assumed to be identical with current-use exposure. Air emissions at each on-site residential receptor are modeled based upon surface-soil concentrations of volatiles at each site.

### **3.2.3 Exposure Pathway Summary**

Human-exposure pathways considered to be complete for this PBRA are:

- Dermal contact with and ingestion of on-site soils by industrial workers.
- Dermal contact with and ingestion of on-site soils by workers and hypothetical future residents at specific sites on eastern, central, and western portions of TEAD-N.
- Groundwater ingestion from downgradient wells by off-site residents and from future on-site wells by hypothetical future on-site residents.
- Inhalation of volatile organics from surface soils by on-site residents, off-site residents, on-site workers, and hypothetical future on-site residents.

Exposure pathways that were not developed are:

- Inhalation of particulates by off-site residents, on-site workers and hypothetical on-site residents.
- Groundwater ingestion by on-site workers.
- Dermal contact and inhalation of volatiles while showering or bathing.
- Consumption of locally raised beef.

Lack of available site-specific information and data precluded the development of all possible pathways in this PBRA. These pathways will be developed, as appropriate, in the BRA.

### **3.3 DERIVATION OF EXPOSURE-POINT CONCENTRATIONS**

Existing data from previous reports were used to estimate exposure concentrations for chemicals of concern in surface soil, groundwater, and air. Maximum chemical concentrations were used for this PBRA to estimate maximum-screening-level exposures at all sites, and average chemical concentrations were also used at 2 and the industrial area. Estimated exposure-point concentrations are presented in Tables 3-2 through 3-7 for current and future land-use scenarios. Appendix I provides the detection limits of the analytical methods used for this investigation.

#### **3.3.1 Current Land Use**

##### **3.3.1.1 Soil**

Exposure-point concentrations for surface-soil ingestion and dermal contact by on-site industrial workers were the maximum reported concentrations at each site, as well as the average concentrations at 2 and the industrial area.

##### **3.3.1.2 Groundwater**

Exposure-point concentrations for groundwater at off-site receptors were derived by modeling the appropriate maximum concentration of chemicals from on-site wells or well groups that were estimated to contribute to a groundwater plume reaching respective receptors. Exposure-point concentrations are estimated to be a small fraction (less than 1 percent) of the maximum concentration of the constituents modeled for each site. Details of the groundwater modeling are presented in Appendix B.

Wells 1, 2, 3, 10 and 16 (see Figure 2-3), located at respective downgradient distances of 39,000, 33,000, 37,500, 31,500 and 28,500 feet from the source, were modeled as receptors for site-related chemicals derived from 1. Well OY, 28,000 feet downgradient, was modeled as a receptor for Sites/SWMUs 10/11, and Well 12, 19,000 feet downgradient,

*Table 3-2. Surface Soil Exposure-Point Concentrations  
Current Use Industrial On-Site Worker  
and Future On-Site Residential*

Constituent	On-Site Worker & Future Residential					
	1	3	7	10/11	Industrial (17,29,32)	
	Max.	Max.	Max.	Max.	Max.	Avg.
Barium	30.7	ND <sup>(a)</sup>	NA <sup>(b)</sup>	39.8	ND/NA <sup>(c)</sup>	603
Beryllium	ND	NA	0.51	ND	ND/NA	ND/NA
Cadmium	0.7	ND	3.2	ND	3.3	1.5
Chromium	NC <sup>(c)</sup>	30.7	NC	NC	33.2	20.1
Fluoride	NA	NA	6.5	ND	NA	NA
Lead	NC	ND	NC	NC	NC	NC
Mercury	NC	ND	ND	ND	ND/NA	ND/NA
Nickel	ND	NA	26.9	NC	81	NC
Nitrate/Nitrite	NA	NA	ND	60.8	NA	NA
Silver	ND	ND	ND	0.02	ND/NA	ND/NA
Zinc	ND	NA	2,000	16.2	1,030	558
Anthracene	NA	NA	ND	ND	ND/NA	ND/NA
Benzo(a)anthracene	NA	NA	ND	ND	0.5	0.42
Benzo(k)fluoranthene	NA	NA	ND	ND	0.6	0.6
Benzo(a)pyrene	NA	NA	ND	ND	0.66	0.55
Bis(2-ethylhexyl)phthalate	NA	NA	ND	ND	ND/NA	ND/NA
Carbon tetrachloride	NA	NA	ND	ND	ND/NA	ND/NA
Chrysene	NA	NA	ND	ND	1.65	0.9
cis-1,2-dichlorobenzene	NA	NA	ND	ND	ND/NA	ND/NA
Dibutyl-phthalate	NA	NA	ND	ND	ND/NA	ND/NA
1,2-Dichlorobenzene	NA	NA	ND	ND	ND/NA	ND/NA
1,3-Dichlorobenzene	NA	NA	NA	NA	ND/NA	ND/NA
1,4-Dichlorobenzene	NA	NA	NA	NA	ND/NA	ND/NA
1,1-Dichloroethane	NA	NA	NA	NA	ND/NA	ND/NA
2,4-Dimethylphenol	NA	NA	NA	NA	ND/NA	ND/NA
2,4-Dinitrotoluene	1.2	NA	ND	8.2	NA	NA
2,6-Dinitrotoluene	1	NA	ND	ND	NA	NA



*Table 3-2. Surface Soil Exposure-Point Concentrations  
Current Use Industrial On-Site Worker  
and Future On-Site Residential (concluded)*

Constituent	On-Site Worker & Future Residential					
	1	3	7	10/11	Industrial (17,29,32)	
	Max.	Max.	Max.	Max.	Max.	Avg.
Ethylbenzene	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	0.61	0.61
HMX	13	NA	ND	95.2	NA	NA
Naphthalene	NA	NA	NA	ND	ND/NA	ND/NA
Phenanthrene	NA	NA	NA	NA	28	28
PCB 1262	NA	NA	NA	NA	0.214	.092
Pyrene	NA	NA	NA	NA	5.4	3.5
Tetrachloroethylene	NA	NA	NA	NA	ND/NA	ND/NA
1,1,1-Trichloroethane	NA	NA	NA	NA	ND/NA	ND/NA
Trichloroethylene	NA	NA	NA	NA	5.63	5.63
1,3,5-Trinitrobenzene	ND	NA	ND	47	NA	NA
2,4,6-Trinitrotoluene	52	NA	ND	20,733	NA	NA
Toluene	NA	NA	NA	NA	ND/NA	ND/NA
m-Xylene	NA	NA	NA	NA	ND/NA	ND/NA
o-Xylene	NA	NA	NA	NA	ND/NA	ND/NA
p-Xylene	NA	NA	NA	NA	ND/NA	ND/NA

<sup>a</sup>ND = not detected.

<sup>b</sup>NA = not applicable.

<sup>c</sup>NC = Not a chemical of concern.

Note.—Concentrations are the maximum or average value (in mg/kg) detected at a site. Chemicals for Sites/SWMUs 17 and 32 were not analyzed; chemicals for 29 were not detected.

*Table 3-3. Groundwater Exposure-Point Concentrations  
Current Off-Site Residential*

Constituent (ug/l)	Site/SWMU		
	1	2/30,12/14/15,29	10,11
Arsenic	ND <sup>(a)</sup>		0.0368
Beryllium	NA <sup>(b)</sup>	0.005	ND
Cadmium	NM <sup>(c)</sup>	0.002	ND
Chromium	NM	0.133	NM
Copper	ND	0.007	0.0111
Fluoride	NA	NM	2.03
Manganese	NA	1.1	NA
Nickel	ND	0.039	NM
Nitrate	2.7	NM	20.82
Thallium	ND	NA	0.005
Benzyl Alcohol	NA	NA	0
Bis(2-ethylhexyl)phthlate	NA	0.105	0
Cyclonite (RDX)	ND	0.005	0.05
Carbon Tetrachloride	NA	0.008	NA
1,2-Dichlorobenzene	NA	0.005	NA
1,3-Dichlorobenzene	NA	0.005	NA
1,4-Dichlorobenzene	NA	0.005	NA
1,1-Dichloroethane	NA	0.03	NM
2,4-Dinitrotoluene	NA	NA	0.01
HMX	NA	NA	0.01
2-Methyl-4,6-Dinitrophenol	NA	NA	0.01
Phenol	NA	NA	0
1,3,5-Trinitrobenzene	NA	NA	0.03
2,4,6-Trinitrotoluene	NA	NA	0.01
Trichloroethylene	ND	0.048	NA
1,1,1-Trichloroethane	NA	0.04	NM

<sup>a</sup>ND = not detected.

<sup>b</sup>NA = not applicable.

<sup>c</sup>NM = not modeled. Chemical concentrations were below MCLs, therefore, they were not modeled for the site.

Note.—Concentrations represent modeled values based on groundwater discharging from site to off-site receptor wells (see Appendix B).

*Table 3-4. Maximum Groundwater Exposure-Point Concentrations  
Future On-Site Residential*

Constituent (µg/l)	1	2	10, 11	12,14,15,29,30
<b><u>INORGANICS</u></b>				
Arsenic	ND <sup>(a)</sup>	5.0	110	22.0
Barium	133	NA <sup>(b)</sup>	94.0	1.6
Beryllium	NA	NA	ND	1.6
Cadmium	120	12.0	ND	15.0
Chromium	18.0	40.0	15.0	720
Copper	ND	16.0	33.0	220
Fluoride	NA	NA	6,640	1.1
Iron	NA	1,600	NA	1,200
Lead	ND	8.0	46.0	45.1
Manganese	NA	5,400	NA	87.0
Nickel	ND	NA	33.0	294
Nitrate	17,500	ND	264,000	10.0
Silver	ND	ND	0.6	2.5
Sodium	36,000	NA	296,000	196
Thallium	ND	ND	3.4	NA
Zinc	300	880	90.0	1,900
<b><u>ORGANICS</u></b>				
Benzene	NA	ND	NA	0.8
Benzyl Alcohol	NA	NA	8.0	NA
Bis(2-ethylhexyl)phthalate	NA	NA	10.0	790
Carbon tetrachloride	NA	20.0	NA	41
Chloroform	NA	ND	2.0	5.0
Cycloalkanes	NA	NA	NA	60.06

*Table 3-4. Groundwater Exposure-Point Concentrations  
Future On-Site Residential (continued)*

Constituent (µg/l)	1	2	10, 11	12,14,15,29,30
<b><u>ORGANICS, continued</u></b>				
Cyclonite (RDX)	ND	NA	160	8.5
1,2-Dichlorobenzene	NA	0.8	NA	ND.NA
1,3-Dichlorobenzene	NA	0.2	NA	ND/NA
1,4-Dichlorobenzene	NA	0.4	NA	ND/NA
1,1-Dichloroethane	NA	150	NA	ND/NA
1,1-Dichloroethene	NA	2.9	NA	5.0
trans-1,2-Dichloroethylene	NA	NA	NA	2.6
2,4-Dinitrotoluene	NA	NA	20.0	NA
Ethylbenzene	NA	0.6	NA	ND/NA
2-Methyl-4,6-Dinitrophenol	NA	NA	27.0	NA
Phenol	NA	NA	3.0	NA
Tetrachloroethylene	NA	0.3	NA	ND/NA
Toluene	NA	1.2	6.0	5.0
1,1,1-Trichloroethane	NA	200	1.8	5.0
Trichloroethylene	ND	250	NA	140
1,3,5-Trinitrobenzene	NA	NA	100	NA
2,4,6-Trinitrotoluene	NA	NA	37.4	NA
m,p-Xylenes	NA	3.8	NA	NA
o-Xylenes	NA	1.0	NA	1.5

<sup>a</sup>ND = not detected.

<sup>b</sup>NA = not applicable.

Note.—Chemicals in s 12/14/15 and 30 were not detected. Chemicals in Site 29 were not analyzed.

*Table 3-5. Air Exposure-Point Concentrations  
Current On-Site Industrial Sites/SWMUs 29/30*

<b>Chemical</b>	<b>Concentration (mg/m<sup>3</sup>)</b>
Benzo(a)anthracene	5.10 E-11
Benzo(a)pyrene	5.69 E-09
Benzo(k)fluoranthene	7.33 E-14
Carbon tetrachloride	7.24 E-06
Chrysene	1.20 E-12
Ethylbenzene	2.33 E-07
Fluoranthene	2.38 E-08
Phenanthrene	1.26 E-07
Pyrene	2.55 E-11
Tetrachloroethylene	7.24 E-06
Toluene	6.12 E-06
1,1,1-Trichloroethane	2.08 E-05
Trichloroethylene	5.69 E-08

Note.—Concentrations are modeled values in the industrial area, based on soil concentrations at the sites (see Appendix A).

*Table 3-6. Air Exposure-Point Concentrations  
Current Residential: Grantsville, Tooele,  
and Stockton, On-Site*

Chemical	Concentration (mg/m <sup>3</sup> )			
	Grantsville	Tooele	Stockton	On-Site Housing
Benzo(a)anthracene	1.11 E-11	9.38 E-11	1.57 E-11	1.04 E-10
Benzo(a)pyrene	1.08 E-09	9.12 E-09	1.53 E-09	1.16 E-08
Benzo(k)Fluoranthene	2.33 E-13	1.96 E-13	3.28 E-13	1.50 E-13
Carbon tetrachloride	2.95 E-06	1.08 E-05	1.92 E-06	4.55 E-06
Chrysene	3.65 E-13	3.08 E-12	5.15 E-13	2.45 E-12
2,4-Dinitrotoluene	1.10 E-07	1.55 E-07	1.69 E-07	4.20 E-07
2,6-Dinitrotoluene	1.48 E-07	7.40 E-08	1.01 E-07	1.54 E-07
Ethylbenzene	9.59 E-08	3.52 E-07	6.26 E-08	1.48 E-07
Fluoranthene	4.52 E-09	3.81 E-08	6.38 E-08	4.84 E-08
HMX	2.42 E-15	3.29 E-15	3.63 E-15	5.14 E-15
Phenanthrene	2.41 E-08	2.03 E-07	3.40 E-08	2.56 E-07
Pyrene	7.07 E-12	5.69 E-11	9.98 E-12	5.18 E-11
Tetrachloroethylene	2.98 E-06	1.09 E-05	1.95 E-06	4.59 E-06
Tetryl	3.93 E-12	1.97 E-12	2.67 E-12	2.91 E-11
Toluene	2.51 E-06	9.20 E-06	1.64 E-06	3.89 E-06
1,1,1-Trichloroethane	8.57 E-06	3.14 E-05	5.59 E-06	1.32 E-05
Trichloroethylene	3.94 E-02	4.84 E-02	1.13 E-02	2.35 E-02
1,3,5-Trinitrobenzene	4.90 E-06	7.34 E-06	7.96 E-06	2.02 E-05
2,4,6-Trinitrotoluene	2.71 E-06	4.06 E-06	4.40 E-06	9.97 E-06

Note.—Concentrations are modeled values at the town boundaries, based on soil concentrations at all sites combined (see Appendix A).

*Table 3-7. Air Exposure-Point Concentrations  
Future On-Site Residential  
Sites/SWMUs 1, 10/11, and 29*

Chemical	Concentrations (mg/m <sup>3</sup> )		
	Site 1	Sites 10, 11	Site 29
Benzo(a)anthracene			3.38E-11
Benzo(a)pyrene			3.29E-09
Benzo(k)fluoranthene			7.07E-14
Chrysene			1.11E-12
2,4-Dinitrotoluene	3.55E-08	1.18E-07	
2,6-Dinitrotoluene	5.05E-07		
Fluoranthene			1.37E-08
HMX	1.44E-15	2.43E-15	
Phenanthrene			7.31E-08
Pyrene			2.15E-11
1,3,5-Trinitrobenzene		5.79E-06	
2,4,6-Trinitrobenzene	1.84E-08	3.19E-06	

Note.—Concentrations are modeled values at the sites, based on soil concentrations at the sites. Based on a 30-year average omission rate, an average wind speed of 4.2 m/s (10 mph) (See Appendix A).

was modeled as a receptor for chemicals derived from the TEAD-N industrial area (Sites/SWMUs 2/30, 12/14/15, and 29). Water quality data through 1988 indicate that Well 12 was approximately 2,000 feet downgradient of the trichloroethylene (TCE) plume (James M. Montgomery, 1988). TCE was the most widespread organic contaminant detected in the groundwater samples. Contaminant plumes downgradient of other sites/SWMUs have not been currently defined.

### **3.3.1.3 Air**

Exposure-point concentrations for volatile organics derived from on-site soil were modeled to off-site receptors at the closest boundaries of Grantsville, the city of Tooele, and Stockton, using a screening-level dispersion model. The air-quality impacts used in the inhalation pathway were estimated with conservative screening methods. The levels of conservatism and the length of the averaging periods do not allow for differentiation between "reasonable maximum" and "reasonable average" air impacts. Therefore, a single set of estimated 10-year-average and 30-year-average impacts are used to represent both the reasonable maximum and average concentrations. Exposure-point concentrations for on-site industrial workers were estimated using the box-model approach. Details of the estimation of emission rates from surface soils and dispersion modeling are described in Appendix A.

## **3.3.2 Future Land Use**

### **3.3.2.1 Soil**

Exposure-point concentrations for dermal contact and surface-soil ingestion by hypothetical future residents on TEAD-N were the maximum reported concentrations at each site, as well as the average concentrations at Site/SWMU 2 and the industrial area.

### **3.3.2.2 Groundwater**

For hypothetical future residential on-site exposure, maximum concentrations of the chemicals determined from an examination of on-site well data were used as exposure-point concentrations for Sites/SWMUs 1, 2, 10/11, and the industrial area to represent reasonable maximum exposure. Average concentrations of chemicals were also used as exposure-point concentrations for Site/SWMU 2 and the industrial area to represent average exposure.

### **3.3.2.3 Air**

Exposure-point concentrations for volatile organics were modeled, as described in Section 3.3.1, for hypothetical on-site residents.



### 3.4 DEVELOPMENT OF CHEMICAL INTAKES

Chemical-specific intakes or CDI were calculated for the exposure pathways identified for quantitative evaluation in Section 3.2. The equations used to determine these exposures and the assumptions employed in the equations are discussed below for the current land use scenario and in section 3.4.2 for the future land use scenario.

#### 3.4.1 Current Land Use

##### 3.4.1.1 *On-Site Industrial Worker*

**3.4.1.1.1 *Soil/Ingestion.*** The intake equation for ingestion of chemicals in soil by workers in the industrial area of TEAD-N is presented in Table 3-8. The soil-ingestion rate (0.05 grams/day) is the standard default value derived by USEPA (1991) for commercial/industrial land use. The fraction ingested from a chemical source is 1.0, calculated under the assumption that all soil ingested by industrial workers is derived from the contaminated sites in the industrial area. The exposure frequency of 250 days per year is the standard EPA default value for commercial/industrial land use. Faculty members at the high school were assumed to be exposed 200 days out of the year. A worker is assumed to remain at TEAD-N for 10 years (average case). The standard default parameters of 70 kilograms for adult body weight (154 pounds) and 70 years for average life span are used (USEPA, 1991). In keeping with current USEPA guidelines (1989), the averaging time used for carcinogens is 70 years and, for non-carcinogens, is the applicable exposure duration, which in this case is 10 years. The difference in averaging times relates to the different mechanisms of action for carcinogens and non-carcinogens, based on the assumption that a higher dose of a carcinogen received over a shorter period of time is equivalent to a corresponding lower dose spread over a lifetime (USEPA, 1989).

**3.4.1.1.2 *Soil/Dermal Contact.*** Potential exposures of on-site industrial workers through dermal contact with chemicals in the soil were calculated using the equation in Table 3-9. Exposure factors used are based on conservative estimates of soil-to-skin adherence and skin absorption. Skin-surface area used is based on 50th-percentile values for head, hands, and forearms of adult males. Exposure frequency and duration are based on the factors discussed above for soil ingestion.

**3.4.1.1.3 *Air/Inhalation of Volatiles from Soil.*** Exposure associated with inhalation of volatilized chemicals released from soil in the industrial area was estimated for workers using the equation shown in Table 3-10. The standard default value of 2.5 m<sup>3</sup> per hour was used for industrial-worker inhalation (USEPA, 1991). An exposure time of 10 hours per day and frequency of 200 days per year are based on the 4-day workweek followed at TEAD-N.

*Table 3-8. Occupational Exposure: Ingestion of Chemicals in Soil  
Reasonable Maximum and Average Exposure Levels*

$$\text{Intake(mg/kg-day)} = \frac{Cs \times IR \times FI \times EF \times ED \times CF}{BW \times AT}$$

Where:

- Cs = Concentrations of Chemical in Soil (mg/kg)
- IR = Adult Ingestion Rate (0.05 g/day; U.S. EPA 1991)
- FI = Fraction Ingested from Chemical Source (1.0)
- EF = Exposure Frequency (250 days per year; U.S. EPA, 1991)
- ED = Exposure Duration (10 years; based on site-specific information)
- CF = Conversion Factor (10<sup>-3</sup> kg/g)
- BW = Adult body Weight (70 kg; U.S. EPA, 1991)
- AT = Averaging time (25,550 days for carcinogens = 70 year lifetime X 365 days/year; 3,650 days for noncarcinogens = exposure duration x 365 days/year)

*Table 3-9. Occupational Exposure: Dermal Contact with Chemicals in Soil  
Reasonable Maximum and Average Exposure Levels*

$$\text{Absorbed Dose(mg/kg-day)} = \frac{Cs \times SA \times AF \times ABS \times EF \times ED \times CF}{BW \times AT}$$

Where:

- Cs = Concentrations of Chemical in Soil (mg/kg)
- SA = Skin Surface Area Available for Contact (3100 cm<sup>2</sup>; U.S. EPA, 1990)
- AF = Soil to Skin Adherence Factor (2.11 mg/cm<sup>2</sup>; Expos. Factors Handbook U.S. EPA, 1988) Superfund Exposure Assessment Manual
- ABS = Adult Skin Absorption Factor (0.001 for metals; 0.4 for organics; U.S. EPA recommendations)
- EF = Exposure Frequency (250 days per year; U.S. EPA, 1991)
- ED = Exposure Duration (10 years; based on site-specific information)
- CF = Conversion Factor (10<sup>-6</sup> kg/mg)
- BW = Adult Body Weight (70 kg)
- AT = Averaging Time (25,550 days for carcinogens; 3,650 days for noncarcinogens)

*Table 3-10. Occupational Exposure: Inhalation of Volatiles from Soil*

$$\text{Intake (mg/kg-day)} = \frac{CA \times IR \times ET \times EF \times ED}{BW \times AT}$$

Where:

- CA = Exposure Point Concentration in Air (mg/m<sup>3</sup>)
- IR = Adult Inhalation Rate (2.5 m<sup>3</sup>/hour; U.S. EPA, 1991)
- ET = Exposure Time (10 hours/workday; U.S. EPA, 1991)
- EF = Exposure Frequency (200 days per year; U.S. EPA, 1991)
- ED = Exposure Duration (10 years; based on site-specific information)
- BW = Adult Body Weight (70 kg)
- AT = Averaging time (25,550 days for carcinogens; 3,650 days for noncarcinogens)

**3.4.1.1.4 Chemical Intakes.** CDI calculated for each of the three exposure pathways for the on-site industrial exposure scenario are contained in Tables 5-1, 5-2, 5-3, 5-11, 5-12, and 5-13 (see section 5.0).

#### **3.4.1.2 Site-Specific Worker**

The same intake equations used for the on-site industrial scenario are used to calculate potential exposures for site-specific workers. CDI are shown in Tables 5-4 and 5-14 (see Section 5.0).

#### **3.4.1.3 On-Site Resident**

CDI are shown in Tables 5-7 and 5-17.

#### **3.4.1.4 Off-Site Resident**

**3.4.1.4.1 Groundwater Ingestion.** Exposure due to ingestion of groundwater containing site-related chemicals by residents living near TEAD-N was calculated separately for children and adults, based on the different ingestion rates and body weights for these groups (see Table 3-11). The reasonable maximum exposure (RME) is represented by 90th-percentile values for ingestion rate (USEPA, 1990) and standard-default values for child and adult

weight and exposure frequency (USEPA, 1991). An exposure duration of 30 years is used, which represents the national upper-bound number of years spent by individuals at one residence (USEPA, 1990).

For the average exposure (see Table 3-12), exposure duration of 9 years and an adult ingestion rate of 1.4 liters/day (USEPA, 1991) are used.

**3.4.1.4.2 Air/Inhalation of Volatiles from Soil.** Inhalation exposures to vapor emissions in ambient air in the three communities near TEAD-N (i.e., Grantsville, Tooele, and Stockton) were estimated separately for children and adults, based on their different inhalation rate, body weight, and exposure time. The intake equation is shown in Table 3-12. The frequency of exposure and body weights are the same used for the groundwater-ingestion pathway. Children are assumed to breathe at a rate of 0.625 m<sup>3</sup> per hour (NCRP, 1985), assuming they get 10 hours of rest and 14 hours of active play each day. The standard-default adult-inhalation rate of 0.83 m<sup>3</sup> per hour is used (USEPA, 1991). An adult exposure time of 16 hours per day is based on the time spent at home as reported in time-use studies (USEPA, 1990). The child exposure time (i.e., 20 hours per day) is a reasonable maximum estimate based on the adult-exposure time. Concentrations of vapors indoors and outdoors are assumed to be equivalent, representing a worst-case scenario. This conservative approach is in keeping with the preliminary nature of this risk assessment, in particular the limited database upon which modeled air concentrations are based.

*Table 3-11. Residential Exposure: Ingestions of Chemicals in Drinking Water*

$$\text{Intake(mg/kg-day)} = \frac{CW \times IR_c \times EF_c \times ED_c}{BW_c \times AT} + \frac{CW \times IR_a \times EF_a \times ED_a}{BW_a \times AT}$$

Where:

- CW = Chemical Concentration in Water (mg/liter)
- IR<sub>c</sub> = Child Ingestion Rate (1 liter/day; U.S. EPA, 1990 Exp. Factors Handbook)
- EF<sub>c</sub> = Child Exposure Frequency (350 days/year)
- ED<sub>c</sub> = Child Exposure Duration (6 years time at one residence)
- BW<sub>c</sub> = Child Body Weight (15 kg; 1991)
- IR<sub>a</sub> = Adult Ingestion rate (2 liters/day; U.S. EPA, 1990)
- EF<sub>a</sub> = Adult Exposure Frequency (350 days/year)
- ED<sub>a</sub> = Adult Exposure Duration (24 years, assumes 30 years at one residence with 6 years spent as a child)
- BW<sub>a</sub> = Adult Body Weight (70 kg)
- AT = Averaging time (pathway specific period of exposure: 25,550 days for carcinogens; 10,950 days for non-carcinogens)

*Table 3-12. Residential Exposure: Ingestion of Chemicals in Drinking Water  
Average Exposure Level*

$$Intake (mg/kg-day) = \frac{CW \times IR_a \times EF_a \times ED_a}{BW_a \times AT}$$

Where:

- CW = Chemical Concentrations in Water (mg/liter)
- IR<sub>a</sub> = Adult Ingestion rate (1.4 liters/day; U.S. EPA, 1990)
- EF<sub>a</sub> = Adult Exposure Frequency (350 days/year)
- ED<sub>a</sub> = Adult Exposure Duration (9 years, assumes 30 years at one residence with 6 years spent as a child)
- BW<sub>a</sub> = Adult Body Weight (70 kg)
- AT = Averaging time (pathway specific period of exposure: 25,500 days for carcinogens; 3,285 days for noncarcinogens)

**3.4.1.4.3 Chemical Intakes.** CDI calculated for off-site residential exposure via groundwater ingestion and volatile inhalation are shown in Tables 5-5, 5-6, 5-8, 5-9, 5-10, 5-15, 5-16, 5-18, 5-19, and 5-20 (see Section 5.0).

### **3.4.2 Future Land Use**

#### **3.4.2.1 On-Site Industrial Worker**

The exposure pathways and intakes for the on-site industrial scenario are the same under future use as those presented in Section 3.4.1 for current land use.

#### **3.4.2.2 Site-Specific Worker**

The exposure pathways and intakes for the site-specific worker scenario also are the same as those for the current land use.

#### **3.4.2.3 On-Site Resident**

**3.4.2.3.1 Soil/Ingestion.** The intake equation for residential soil ingestion (Table 3-13) accounts for the difference between child and adult rates of soil ingestion (i.e., children typically ingest much more soil than adults). Exposure is calculated as a weighted average of child and adult exposures, based on different ingestion rates and body weights.

A child ingestion rate of 0.2 grams per day and an adult ingestion rate of 0.1 grams per day are standard default factors (used for RME level calculations), as are an exposure frequency of 350 days per year and a 30-year length of residence (exposure duration) at one residence (USEPA, 1991). Average exposure-level calculations assume a 10-year length of residence (USEPA, 1991). The fraction of soil ingested from chemical source is 1.0, which assumes all soil ingested by potential residents of a site would come from that site.

**3.4.2.3.2 Soil/Dermal Contact.** Residential exposure due to skin absorption of site-related chemicals from surface soil is calculated separately for children and adults because they have different body weights, skin-surface areas available for contact, and skin-absorption factors. Exposure factors used in the intake equation (see Table 3-14) are based on conservative estimates of soil-to-skin adherence, skin absorption, and duration of exposure. Different absorption factors are used for metals and organics. Exposure frequency (i.e., 350 days/year) is a standard default factor (USEPA, 1991). Skin-surface areas used are 50th-percentile values for the body parts representing the reasonable worst case: head, hands, forearms, and lower legs for children and heads, hands, and forearms for adults (USEPA, 1990).

*Table 3-13. Residential Exposure: Inhalation of Volatiles From Soil  
Reasonable Maximum and Average Exposure Levels*

$$\text{Intake (mg/kg-day)} = \frac{CA \times IR_c \times ET_c \times EF_c \times ED_c}{BW_c \times AT} + \frac{CA \times IR_a \times ET_a \times EF_a \times ED_a}{BW_a \times AT}$$

Where:

- CA = Exposure Point Concentration in Air (mg/m<sup>3</sup>)
- IR<sub>c</sub> = Child Inhalation Rate for 1 to 6 year old (0.625 m<sup>3</sup>/hr; NCRP, 1985)
- ET<sub>c</sub> = Child Exposure Time (20 hours/day)
- EF<sub>c</sub> = Frequency of Child Exposure (350 days/year; U.S. EPA, 1991)
- ED<sub>c</sub> = Duration of Child Exposure (Reasonable Maximum Exposure, 6 years; Average Exposure, 0 years)
- BW<sub>c</sub> = Child Body Weight (15 kg)
- IR<sub>a</sub> = Adult Inhalation Rate (0.83 m<sup>3</sup>/hr; U.S. EPA, 1991)
- ET<sub>a</sub> = Adult Exposure Time (16 hours/day; U.S. EPA, 1990)
- EF<sub>a</sub> = Frequency of Adult Exposure (350 days/year; U.S. EPA, 1991)
- ED<sub>a</sub> = Duration of Adult Exposure (Current On-Site, 4 years; Future On-Site and Off-Site, 24 years for Reasonable Maximum Exposure and 9 years for Average Exposure)
- BW<sub>a</sub> = Adult Body Weight (70 kg)
- AT = Average Time (25,500 days for carcinogens; 10,950 days for noncarcinogens, Reasonable Maximum Exposure; 3,285 days for noncarcinogens, Average Exposure)

Table 3-14. Residential Exposure: Dermal Contact with Chemicals in Soil  
Reasonable Maximum and Average Maximum Exposure Levels

$$\text{Absorbed Dose (mg/kg-day)} = \frac{CA \times SA_c \times AF \times ABS_c \times EF \times ED_c \times CF}{BW_c \times AT} + \frac{Cs \times SA_a \times AF \times ABS_a \times EF_a \times ED_a \times CF}{BW_a \times AT}$$

Where:

Cs	=	Concentration of Chemical in Soil (mg/kg)
SA <sub>c</sub>	=	Child Exposed Surface Area (2,900 cm <sup>2</sup> /event, U.S. EPA, 1990 Exp. Factors Handbook)
AF	=	Soil to Skin Adherence Factor (2.11 mg/cm <sup>2</sup> , U.S. EPA, 1988 Superfund Exp. Assess. Manual)
ABS <sub>c</sub>	=	Child Skin Absorption Factor (0.001 for metals; 0.4 for organics; U.S. EPA recommendations)
EF <sub>c</sub>	=	Frequency of Child Exposure (350 days/year; U.S. EPA, 1991)
ED <sub>c</sub>	=	Durations of Child Exposure (6 years for reasonable maximum exposure and 0 years for average exposure)
CF	=	Conversion Factor (10 <sup>-6</sup> kg/mg)
BW <sub>c</sub>	=	Child Body Weight (15 kg, U.S. EPA, 1991 Default Exp. Factors)
SA <sub>a</sub>	=	Adult Exposed Surface Area (3,100 cm <sup>2</sup> /event, U.S. EPA, 1990)
ABS <sub>a</sub>	=	Adult Skin Absorption Factor (0.001 for metals; 0.4 for organics; U.S. EPA recommendations)
EF <sub>a</sub>	=	Frequency of Adult Exposure (350 days/years; U.S. EPA, 1991)
ED <sub>a</sub>	=	Duration of Adult Exposure (current on-site, 4 year; future on-site and off-site, 24 years for reasonable maximum exposure and 9 years for average exposure)
BW <sub>a</sub>	=	Adult Body Weight (70 kg)
AT	=	Averaging Time (25,500 days for carcinogens; 10,950 days for noncarcinogens (reasonable maximum exposure; 3,285 days for noncarcinogens, average exposure)



**3.4.2.3.3 Groundwater Ingestion.** The intake equation (see Table 3-8) is the same as that used for residential-groundwater ingestion in Section 3.4.1, Current Land Use. All of the exposure parameters remain the same.

**3.4.2.3.4 Air/Inhalation of Volatiles from Soil.** Estimated chemical intake by inhalation of volatiles from soil by potential future residents of the site is calculated by means of the same equation and parameters (see Table 3-12) used for residential inhalation of volatiles by off-site residents under current land use.

**3.4.2.3.5 Chemical Intakes.** CDI for the four pathways evaluated for potential on-site residents are presented in Tables 5-21 through 5-43.

### **3.5 UNCERTAINTY**

Uncertainty in the exposure assessment derives, in part, from the incomplete characterization of affected media and the extent of contamination at some waste sites. Exposure-point concentrations could not be calculated for all complete pathways because of data limitations such as no reliable air-particulate concentrations and no appropriate site meteorological data. Particulate monitoring will be done and incorporated in the Draft BRA.

Uncertainty in derivation of exposure-point concentrations is inherent in emission rate and transport assumptions, both of which are necessary for input into the transport models for chemicals in air and groundwater.

The applicability of selected models for given exposure scenarios causes uncertainty and diminishes confidence levels of modeled output.

In the calculation of chemical intakes, it was necessary to estimate several parameter values for use in the intake equations, in particular: soil adherence and absorption factors for dermal absorption of site-related chemicals in soil, exposure times for residential inhalation of volatiles, and fractional amounts of soil ingested from chemical source. Soil adherence and absorption factors as well as inhalation exposure times were derived from typical values found in the literature. The conservative estimate of fractional amounts ingested assumes that all ingested soil is from the site. A number of other exposure parameters are standard default values supplied by USEPA for use at locations where site-specific exposure information is not available. These include exposure frequencies for contact with soil, groundwater, and air; soil and groundwater ingestion rates; and inhalation rates.

Although the eastern portion of the site is expected to remain industrial for the reasonably foreseeable future, a future residential scenario was developed for the PBRA. Because future residential use is an unlikely scenario, resultant risk estimates may be an overestimate of risk posed by this portion of the site.

## **4.0 TOXICITY ASSESSMENT**

An overview of the toxicity of the chemicals of concern is given in this section. Toxicity profiles that more completely characterize the health effects of these chemicals, as well as their environmental fate and behavior in biological systems, are provided in Appendix D.

### **4.1 CARCINOGENS**

The U.S. Environmental Protection Agency (EPA) classification system, based on the strength of evidence that a chemical is a human carcinogen, places each chemical into one of the following classes: A—sufficient human evidence; B1—limited human evidence but sufficient animal evidence; B2—inadequate human evidence but sufficient evidence in animals (both considered probable carcinogens); C—no evidence in humans and limited evidence in animals; D—no adequate data (non-classifiable); and E—evidence of noncarcinogenicity. Table 4-1 summarizes the carcinogenic classifications for the chemicals of concern.

The EPA's Carcinogen Assessment Group calculates slope factors—estimates of the excess cancer risk due to continuous exposure to a chemical throughout the course of a 70-year lifetime—for suspected carcinogens. Slope factors for the chemicals of concern that are carcinogens are shown in Table 4-1. A number of these chemicals do not currently have verified slope factors because they have either not been determined or have not been evaluated by EPA. Oral slope factors are used for ingestion pathways.

### **4.2 NONCARCINOGENS**

The primary toxic effects of most of the organic noncarcinogenic compounds of concern occur in the liver and/or kidneys. These effects are often combined with central nervous system depression. Critical effects for inorganic chemicals occur in the blood and the thyroid, cause a decrease in weight, and affect the central nervous system.

Reference doses (RfDs) developed by the EPA are estimates of the daily dose of a chemical to which humans, including sensitive subpopulations, can be exposed without an appreciable risk of deleterious effects during a lifetime. The basis of an RfD is usually the highest level tested in animal experiments at which no adverse effects were demonstrated (i.e., NOAEL or No Observed Adverse Effect Level). The NOAEL is divided by uncertainty and modifying factors to obtain an RfD. Verified RfDs, which have been peer-reviewed and accepted by the EPA, are shown in Table 4-2 for the chemicals of concern. Verified RfDs are available for most of these chemicals. Several of the RfDs are under review or have not been determined to date. Oral RfDs are used for ingestion pathways.

### **4.3 UNCERTAINTY ANALYSIS**

The estimates of human-health risks developed in this PBRA required a number of assumptions about exposure and subsequent adverse health effects.

*Table 4-1. Toxicity Values: Carcinogenic Effects  
Chemicals of Concern*

Chemical	Slope Factors		Weight-of-Evidence Classification	Source
	Oral (mg/kg/day) <sup>-1</sup>	Inhalation (mg/kg/day) <sup>-1</sup>		
METALS				
Arsenic	1.75E+1	5.0E+1	A	HEAST/IRIS
Barium	ND <sup>(a)</sup>	ND	ND	HEAST <sup>(b)</sup>
Beryllium	4.3E+0	8.4E+0	B2	IRIS <sup>(c)</sup>
Cadmium	ND	6.1E+0	B1	HEAST
Chromium	ND	4.1E+1	A	HEAST
Copper	--	--	D	HEAST
Iron	ND	ND	ND	HEAST/IRIS
Lead	ND	ND	B2	HEAST/IRIS
Manganese	ND	ND	ND	HEAST/IRIS
Mercury	--	--	D	HEAST
Nickel	ND	8.4E-1	A	HEAST
Silver	--	--	--	HEAST
Thallium	--	--	--	HEAST
Zinc	--	--	--	HEAST
ORGANICS				
Anthracene	--	--	D	IRIS
Benzene	2.9E-2	2.9E-2	A	HEAST
Benzo(a)anthracene	11.5*	6.1*	B2	HEAST
Benzo(k)fluoranthene	11.5*	6.1*	B2	HEAST
Benzo(a) pyrene	11.5	6.1	B2	HEAST
Benzyl alcohol	--	--	--	HEAST
Bis (2-ethylhexyl) phthalate	1.4E-2	ND	B2	HEAST
Carbon tetrachloride	1.3E-01	1.3E-1	B2	HEAST
Chloroform	6.1E-3	8.1E-2	B2	HEAST

*Table 4-1. Toxicity Values: Carcinogenic Effects  
Chemicals of Concern (continued)*

Chemical	Slope Factors		Weight-of-Evidence Classification	Source
	Oral (mg/kg/day) <sup>-1</sup>	Inhalation (mg/kg/day) <sup>-1</sup>		
ORGANICS (continued)				
Chrysene	11.5*	6.1*	B2	IRIS
Dibutyl phthalate	--	--	D	HEAST/IRIS
1,2-Dichlorobenzene	--	--	D	IRIS
1,3-Dichlorobenzene	ND	ND	ND	HEAST/IRIS
1,4-Dichlorobenzene	2.4E-2	ND	C	HEAST
1,1-Dichloroethane	ND	ND	C	IRIS
cis-1,2-Dichloroethene	--	--	--	HEAST/IRIS
2,4-Dimethylphenol	--	--	--	HEAST/IRIS
2,4-Dinitrotoluene	6.8E-1	ND	B2	HEAST
2,6-Dinitrotoluene	6.8E-1	ND	B2	HEAST
Ethylbenzene	--	--	D	HEAST
Fluoranthene	--	--	D	HEAST/IRIS
HMX (cyclotetra-methylenetrinitramine)	--	--	D	IRIS
Methylene chloride	7.5E-03	1.6E-03	B2	HEAST/IRIS
2-methyl-4,6-dinitrophenol	--	--	--	HEAST/IRIS
Napthalene	--	--	--	HEAST/IRIS
PCB 1262 (Archlor 1260)	7.7E+0	ND	B2	HEAST
Phenanthrene	--	--	D	HEAST/IRIS
Phenol	--	--	--	HEAST/IRIS
Pyrene	11.5*	6.1*	D	IRIS
RDX	1.1E-1	ND	C	IRIS
Tetrachloroethylene	5.1E-02	2.0E-03	B2	HEAST
Thallium	--	--	--	HEAST/IRIS

*Table 4-1. Toxicity Values: Carcinogenic Effects  
Chemicals of Concern (concluded)*

Chemical	Slope Factors		Weight-of-Evidence Classification	Source
	Oral (mg/kg/day) <sup>-1</sup>	Inhalation (mg/kg/day) <sup>-1</sup>		
ORGANICS (concluded)				
1,1,1-Trichloroethane	(under review)	(under review)	D	HEAST/IRIS
Trichloroethylene	1.1E-02	6E-03 <sup>1</sup>	--	HEAST/IRIS
1,3,5-Trinitrobenzene	ND	ND	ND	IRIS
2,4,6-Trinitrotoluene	3.0E-2	ND	C	HEAST
Toluene	--	--	D	HEAST
m-Xylene	--	--	D	HEAST
o-Xylene	--	--	D	HEAST
p-Xylene	--	--	D	HEAST
INORGANICS				
Fluoride	--	--	--	HEAST/IRIS
Nitrate/Nitrite	--	--	--	HEAST/IRIS

<sup>(a)</sup>ND - Not determined.

<sup>(b)</sup>HEAST - Health Effects Assessment Summary Tables, 1991.

<sup>(c)</sup>IRIS - Integrated Risk Information System, 1992.

1 - Slope factors were derived by converting the unit risk to a dose.

\*All Class 82 polycyclic aromatic hydrocarbons which do not have chronic slope factors (oral) listed by IRIS or HEAST are assumed to be equipotent with benzo(a)pyrene.

Table 4-2. Toxicity Values: Noncarcinogenic Effects  
for Chemicals of Concern

Chemical	Chronic RfDs <sup>(a)</sup>			Critical Effect		Uncertainty		Source
	Oral	Inhalation	Inhalation	Inhalation	Oral	Inhalation	Oral	
	(mg/kg/day)							
Metals								
Arsenic	3.0E-4	ND <sup>(b)</sup>	NA <sup>(c)</sup>	NA <sup>(c)</sup>	Keratosis and hyperpigmentation	NA	1	HEAST/IRIS <sup>(d)</sup>
Barium	7E-2	1E-4	Fetotoxicity	Fetotoxicity	Increased blood pressure	1000	100	HEAST
Beryllium	5E-3	ND	NA	NA	None observed	NA	100	HEAST
Cadmium	1E-3 (food) 5E-4 (water)	ND	Cancer	Cancer	Renal damage	NA	10	HEAST
Chromium	5E-3	6E-7*	Nasal Mucosa Atrophy	Nasal Mucosa Atrophy	Not defined	30	100	HEAST
Copper	1.3 mg/L	ND	NA	NA	Local GI <sup>(e)</sup> irritation	NA	NA	HEAST
Lead	ND	ND	CNS effects	CNS effects	CNS <sup>(f)</sup> Effects	NA	NA	HEAST
Iron	ND	ND	ND	ND	ND	ND	ND	HEAST/IRIS
Manganese	1.0E-1	1E-4*	Respiratory symptoms and psychomotor disturbances	Respiratory symptoms and psychomotor disturbances	No effect	900	1	HEAST/IRIS
Mercury	3.0E-4	9E-5*	Neurotoxicity	Neurotoxicity	Kidney effects	30	1000	HEAST
Nickel	2.0E-2	ND	Cancer	Cancer	Reduced body and organ weight	NA	300	IRIS
Silver	3.0E-3	ND	NA	NA	Argyria	NA	2	HEAST/IRIS
Thallium	7.5E-05	ND	NA	NA	Increased SGOT <sup>(g)</sup> and serum LDH <sup>(h)</sup> levels, alopecia	NA	3000	HEAST
Zinc	2.0E-1	ND	NA	NA	Anemia	NA	10	HEAST

Table 4-2. Toxicity Values: Noncarcinogenic Effects  
for Chemicals of Concern (continued)

Chemical	Chronic RfDs <sup>(a)</sup>		Critical Effect		Uncertainty		Source
	Oral	Inhalation	Inhalation	Oral	Inhalation	Oral	
	(mg/kg/day)						
Organics							
Anthracene	3.0E-1	ND	NA	None Observed, No Effects	NA	300	HEAST
Benzyl alcohol	3.0E-1	NA	NA	Hyperplasia of the epithelium of the forestomach	NA	1000	HEAST/IRIS
Benzo(a)anthracene	ND	ND	ND	ND	ND	ND	HEAST/IRIS
Benzo(k)fluoranthene	ND	ND	ND	ND	ND	ND	HEAST/IRIS
Benzo(a)pyrene	ND	ND	ND	ND	ND	ND	HEAST/IRIS
Bis(2-ethylhexyl) phthalate	2.0E-2	ND	NA	Increased relative liver weight	NA	1000	HEAST/IRIS
Carbon tetrachloride	7.0E-4	ND	NA	Liver lesions	NA	1000	HEAST/IRIS
Chloroform	1.0E-2	ND	NA	Liver lesions	NA	1000	HEAST/IRIS
Chrysene	ND	ND	ND	ND	ND	ND	HEAST/IRIS
Dibutyl phthalate	1.0E-1	ND	NA	Mortality	NA	1000	HEAST/IRIS
1,2-Dichlorobenzene	9.0E-2	4E-2	Decreased body weight gain	Liver effects	1000	1000	HEAST/IRIS
1,3-Dichlorobenzene	ND	ND	ND	ND	ND	ND	HEAST/IRIS
1,4-Dichlorobenzene	ND	2E-1*	Liver and kidney effects	NA	100	NA	HEAST/IRIS
1,1-Dichloroethane	1.0E-1	1.0E-1	Kidney damage	None Observed	1000	1000	HEAST/IRIS

Table 4-2. Toxicity Values: Noncarcinogenic Effects  
for Chemicals of Concern (continued)

Chemical	Chronic RfDs <sup>(a)</sup>		Critical Effect		Uncertainty		Source
	Oral	Inhalation (mg/kg/day)	Inhalation	Oral	Inhalation	Oral	
Organics							
1,1-Dichloroethene	9.0E-3	ND	NA	Liver lesions	NA	1000	HEAST/IRIS
1,2-c-Dichloroethene	1.0E-2	ND	NA	Decreased hemoglobin and hematocrit	NA	300	HEAST/IRIS
2,4-Dimethylphenol	2.0E-2	ND	NA	Neurological signs and hematological changes	NA	3000	HEAST/IRIS
2,4-Dinitrotoluene	ND	ND	ND	ND	ND	ND	HEAST/IRIS
2,6-Dinitrotoluene	ND	ND	ND	ND	ND	ND	HEAST/IRIS
Ethylbenzene	1.0E-1	3E-1*	Developmental Toxicity	Hepatotoxicity and Nephrotoxicity	300	1000	HEAST/IRIS
Fluoranthene	4.0E-2	ND	NA	Nephropathy; liver weight changes, hematological changes	NA	3000	HEAST/IRIS
HMX(cyclotetra-methylenetetranitro-amine)	5.0E-2	ND	Hepatic lesions		--	1000	HEAST/IRIS
2-methyl-4,6-Dinitrophenol	ND	ND	ND	ND	ND	ND	HEAST/IRIS
Methylene chloride	6.0E-2	9E-1*	NA	Liver toxicity	100	100	HEAST/IRIS



Table 4-2. Toxicity Values: Noncarcinogenic Effects  
for Chemicals of Concern (continued)

Chemical	Chronic RfDs <sup>(a)</sup>			Critical Effect		Uncertainty		Source
	Oral	Inhalation	(mg/kg/day)	Inhalation	Oral	Inhalation	Oral	
<b>Organics</b>								
Napthalene	4.0E-3	ND		NA	Decreased body weight gain	NA	10,000	HEAST/IRIS
PCB 1262 (Aroclor 1260)	ND	ND		ND	ND	ND	ND	HEAST/IRIS
Phenanthrene	ND	ND		ND	ND	ND	ND	ND
Phenol	6.0E-1	ND		NA	Reduced fetal body weight	NA	100	HEAST
Pyrene	3.0E-2	ND		NA	Renal effects	NA	3000	ND
RDX (cyclonite)	3.0E-3	ND		NA	Prostate inflammation, hemosiderosis	NA	100	ND
Tetrachloroethylene	1.0E-2	ND		NA	Hepatotoxicity	NA	1000	ND
Thallium	7.0E-5	ND		NA	Increased SGOT and serum LDH levels, alopecia	NA	3000	HEAST/IRIS
Toluene	2.0E-1	6E-1*		CNS effects, eye and nose irritation	Changes in liver and kidney weights	100	1000	ND
Trichloroethylene	ND	ND		ND	ND	ND	ND	ND
1,1,1-Trichloroethane	9.0E-2	3E-1		Hepatotoxicity		1000	1000	ND
1,3,5-Trinitrobenzene	5.0E-5	ND		NA	Increased spleen weight	NA	10,000	ND

Table 4-2. Toxicity Values: Noncarcinogenic Effects  
for Chemicals of Concern (concluded)

Chemical	Chronic RfDs <sup>(a)</sup>		Critical Effect		Uncertainty		Source
	Oral	Inhalation	Inhalation	Oral	Inhalation	Oral	
	(mg/kg/day)						
Organics							
2,4,6-Trinitrotoluene	5.0E-4	ND	NA	Liver effects	NA	1000	ND
m-Xylene	2.0E+0	2E-1	Hepatomegaly	Hyperactivity, decreased body weight, increased mortality at higher doses	5000	100	ND
o-Xylene	2.0E+0	2E-1	Fetotoxicity	None observed	5000	100	HEAST/IRIS
p-Xylene	ND	9E-2*	CNS effects, nose and throat	NA	100	NA	HEAST/IRIS
Inorganics							
Fluoride	6.0E-2	ND	ND	Dental fluorosis at higher levels	NA	1	HEAST/IRIS
Nitrate	ND	ND	ND	ND	ND	ND	HEAST/IRIS
Nitrite	1.0E-1	ND	NA	Methemoglobinemia	NA	10	HEAST/IRIS

RfDs = reference doses

<sup>a</sup>RfDs = reference doses.

<sup>b</sup>ND = not determined.

<sup>c</sup>NA = not applicable.

<sup>d</sup>HEAST = Health Effects Assessment Summary tables, 1991; and IRIS = Integrated Risk Information System, 1991-92.

<sup>e</sup>GI = gastrointestinal.

<sup>f</sup>CNS = central nervous system.

<sup>g</sup>SGOT =

<sup>h</sup>LDH =

<sup>i</sup>Inhalation RfD values were derived from a concentration in air (mg/m<sup>3</sup>) to an inhaled dose (mg/kg-day) by the following equation: air concentration x (20m<sup>3</sup>/day/70 kg) = Inhaled Dose (HEAST).

Site-specific uncertainties are included in the exposure assessment (see Section 3.0). Uncertainty associated with the toxicity values presented in the toxicity assessment (see Section 4.0) is summarized in Tables 4-1 and 4-2. Nine of the carcinogens identified lack oral-slope factors, and seven volatiles lack inhalation-slope factors. Sixteen of the chemicals lack reference doses and 15 of the volatiles do not have reference doses. Four of the chemicals of potential concern—arsenic, chromium, nickel, and benzene—are known Class A carcinogens. The unavailability or lack of slope factors for two of these chemicals—chromium and nickel—increases uncertainty and the possibility for underestimation of potential risks.

Oral-reference-dose data were also unavailable or not determined for some of the chemicals of concern. Due to the lack of these reference doses, the possibility for underestimation of site hazards exists. For several chemicals, the carcinogenic-inhalation unit risk (expressed as a concentration) or the non-carcinogenic references concentration was converted to a dose (mg/kg-day) in order to calculate risk or hazard levels, respectively. The assumptions used in those conversions contribute to uncertainty in the toxicity assessment.

Oral-slope factors and oral RfDs were adjusted by a factor to account for gastrointestinal (GI) absorbance, giving adjusted values (see Tables 4-3 and 4-4). Data on GI absorbance factors, metals, and inorganics were assumed to have a 5-percent GI absorbance and organics, a 95-percent GI absorbance.

*Table 4-3. Dermal Toxicity Values: Carcinogenic Effects  
Chemicals of Concern*

Chemical	% GI <sup>(a)</sup> Adsorption	Adjusted Oral Slope Factor (mg/kg/day) <sup>-1</sup>	Reference
Beryllium	Assume 5 %	8.6E+1	HSDB <sup>(b)</sup>
Benzo(a)anthracene	Assume 95 %	1.2E+01	1 <sup>(c)</sup>
Benzo(a)pyrene	88 %	13.1E+0	ATSDR <sup>(d)</sup>
Benzo(k)fluoranthene	Assume 95 %	1.2E+01	1
Bis(2-ethylhexyl)phthalate	70 %	1.5E-2	ATSDR
Carbon Tetrachloride	Assume 95 %	1.4E-01	HSDB
Chrysene	Assume 95 %	1.2E+01	1
1,4-Dichlorobenzene	Assume 95 %	2.5E-2	HSDB
2,4-Dinitrotoluene	Assume 95 %	7.2E-01	HSDB
2,6-Dinitrotoluene	Assume 95 %	6.5E-01	1
PCB 1262	90 %	8.5E+0	ATSDR
Pyrene	Assume 95 %	1.2E+01	1
Tetrachloroethylene	30 %	1.7E-1	HSDB
Trichloroethylene	Assume 95 %	1.2E-02	HSDB
2,4,6-Trinitrotoluene	Assume 95 %	3.1E-2	1

<sup>a</sup>GI = gastrointestinal.

<sup>b</sup>HSDB = Hazardous Substances Data Bank, National Library of Medicine.

<sup>c</sup>1 = No dermal adsorption data was available for several chemicals. Based upon known adsorption values for organics and metals, the dermal adsorption factor for metals and inorganics was assumed to be 5% and the factor for organics was assumed to be 95%.

<sup>d</sup>ATSDR = Agency for Toxic Substances and Disease Registry Toxicological Profiles.

*Table 4-4. Dermal Toxicity Values: Noncarcinogenic Effects  
for Chemicals of Concern*

Chemical	% GI <sup>(a)</sup> Adsorption	Adjusted Oral Reference Dose (mg/kg/day)	Reference Dose
Barium	Assume 5 %	3.5E-3	1 <sup>(b)</sup>
Beryllium	Assume 5 %	2.5E-4	HSDB <sup>(c)</sup>
Cadmium	8 %	8.0E-5 Food 4.0E-5 H <sub>2</sub> O	HSDB
Chromium	20 %	1.0E-3	HSDB
Lead	2 %	No RfD	HSDB
Mercury	.01 %	3.0E-8	HSDB
Nickel	5 %	1.0E-3	HSDB
Silver	8.21 %	2.5E-4	HSDB
Zinc	Assume 5 %	1.0E-2	1
Anthracene	Assume 5 %	2.85E-1	1
Bis(2-ethylhexyl)phthalate	90 %	1.8E-2	ATSDR <sup>(d)</sup>
Carbon tetrachloride	Assume 95 %	6.6E-4	HSDB
Dibutyl Phthalate	100 %	1.0E-1	ATSDR
1,2-Dichlorobenzene	Assume 95 %	8.5E-2	1
1,1-Dichloroethane	Assume 95 %	9.5E-2	1
Fluoranthene	Assume 95 %	3.8E-2	1
Napthalene	75 %	3.0E-3	HSDB
Pyrene	Assume 95 %	9E-2	1
Tetrachloroethylene	30 %	3.0E-3	HSDB
Toluene	Assume 95 %	1.9E-1	1
1,3,5-Trichlorobenzene	Assume 95 %	4.8E-5	1
2,4,6-Trinitrotoluene	Assume 95 %	4.8E-4	1
Xylene	Assume 95 %	1.9E+0	HSDB
Fluoride	Assume 5 %	3.0E-3	1
Nitrite	Assume 5 %	5.0E-3	1

<sup>a</sup>GI = gastrointestinal.

<sup>b</sup>1 = No dermal adsorption data was available for several chemicals. Based upon known absorption values for organics and metals, the dermal absorption factor for metals and inorganics was assumed to be 5% and the factor for organics was assumed to be 95%.

## 5.0 RISK CHARACTERIZATION

Potential human health risks due to maximum exposures were estimated for each chemical of concern. Carcinogenic and non-carcinogenic effects were calculated separately for each exposure scenario. Noncarcinogenic effects of carcinogenic compounds were included in the calculation of the noncarcinogenic hazard index when appropriate reference doses were available.

### Carcinogenic Risks

The incremental probability of an individual developing cancer over a lifetime exposure was calculated for the chemicals of concern classified as carcinogens by means of the following equation:

$$\text{Risk} = \text{CDI} \times \text{Slope Factor.}$$

It should be noted here that the slope factor is the upper-95th-percentile confidence-limit estimate of human risk extrapolated from the multistage model dose-response curve and that CDI is based on maximum exposure-point concentrations. Therefore, this equation results in a conservative estimate of carcinogenic risk.

The oral-slope factor was used to calculate risk for the groundwater, soil ingestion, and dermal absorption pathways. The total carcinogenic risk in each pathway was calculated by summing the carcinogenic risks posed by each of the carcinogens in that pathway. This method of adding risks, recommended by EPA in its Guidelines for the Health Risk Assessment of Chemical Mixtures (U.S. EPA, 1986), may be overly conservative in that the slope factors, as an upper-95th-percentile estimate of potency, are not strictly additive.

A carcinogenic risk larger than  $1 \text{ E}^{-06}$  is typically considered to represent a significant risk for potential carcinogenic effects. The range of risk representing remediation goals at NPL sites is  $1 \text{ E}^{-04}$  to  $1 \text{ E}^{-06}$ .

### Noncarcinogenic Effects

The potential for noncarcinogenic toxicity to occur in an exposed individual is evaluated by comparing the exposure level with a reference dose, as follows:

$$\text{Hazard Quotient} = \text{CDI/Reference Dose}$$

If the hazard quotient is less than one, it is unlikely that even sensitive populations would experience adverse health effects. If the quotient exceeds unity, however, there may be concern for potential non-carcinogenic effects (U.S. EPA, 1989). To assess the overall potential for non-carcinogenic effects posed by exposure to multiple chemicals, a hazard index equal to the sum of the hazard quotients was calculated (in accordance with U.S. EPA,

1986) for each pathway. As with the hazard quotient, if the hazard index exceeds unity, there may be concern for potential adverse health effects.

## **5.1 CURRENT LAND USE**

The risk estimates for each exposure scenario evaluated under current site use conditions are presented in Tables 5-1 through 5-10. They are discussed below, first for carcinogenic effects and then for non-carcinogenic effects.

### **5.1.1 Carcinogens**

#### **5.1.1.1 *On-Site Industrial Worker***

The potential carcinogenic risks for on-site industrial workers through dermal contact with and incidental ingestion of soil are presented in Table 5-1 and Table 5-2. The total soil pathway risks from dermal exposure are  $3.9 \text{ E}^{-04}$  RME and  $2.1 \text{ E}^{-04}$  average exposure, while those from ingestion are  $7.6 \text{ E}^{-06}$  RME and  $4.5 \text{ E}^{-06}$  average exposure. The total site risk for the soil pathway is  $4.0 \text{ E}^{-04}$  RME and  $2.1 \text{ E}^{-04}$  average exposure. The total pathway risk (RME) from inhalation of volatiles released from soil is  $2.8 \text{ E}^{-08}$  (see Table 5-3). Risks to school personnel in the administrative area were not calculated. These risks would be less than risks for on-site industrial workers due to lower exposure frequency, shorter duration, and greater distance from the source for the inhalation pathway. And the risk for on-site workers was within acceptable levels.

#### **5.1.1.2 *Site-Specific Worker***

The total carcinogenic risk for workers from contact with surface soil at Site/SWMU 1 is  $1.2 \text{ E}^{-05}$  (see Table 5-4). The risk from dermal exposure to soil is  $1.2 \text{ E}^{-05}$  and from soil ingestion is  $2.2 \text{ E}^{-07}$ . Risks from inhalation of volatiles could not be quantified because slope factors were not available. Sites/SWMUs 3, 7, and 10/11 are not active under current land use.

#### **5.1.1.3 *Off-Site Resident***

The carcinogenic risks for off-site residential exposure to groundwater impacted by Site/SWMU 1 could not be calculated. Nitrate, the only chemical of concern, does not have a slope factor available.

The estimated carcinogenic risk for off-site residential ingestion of groundwater from Well 12, if influenced by Sites/SWMUs 2/30, 12/14/15, and 29, is  $1.1 \text{ E}^{-05}$  (see Table 5-5). The primary contributor to risk is TCE, with a chemical-specific risk value of  $1.1 \text{ E}^{-05}$ . The total pathway risk calculated for off-site residential ingestion of groundwater from Well OY, if impacted by Sites/SWMUs 10/11, is  $6 \text{ E}^{-07}$  (see Table 5-6).

*Table 5-1. Surface Soil Risk Characterization: Carcinogenic Effects  
Reasonable Maximum Exposure Level  
Current Use On-Site Industrial Sites/SWMUs 17, 29, 32*

Chemical	CDI <sup>(a)</sup> (mg/kg/day)	Adjusted Oral Slope Factor (mg/kg/day) <sup>-1</sup>	Chemical-Specific Risk
<u>Pathway: Dermal Exposure</u>			
Benzo(a)anthracene	1.7E-06	1.2+01	2.0E-05
Benzo(k)fluoranthene	2.2E-06	1.2E+01	2.6E-05
Benzo(a)pyrene	2.3E-06	1.3E+01	1.7E-05
Chrysene	8.7E-06	1.2E+01	1.0E-04
PCB 1262	7.6E-07	8.5E+00	6.5E-06
Pyrene	1.8E-05	1.2E+01	2.2E-04
Trichloroethylene	2.0E-07	1.2E-02	2.4E-09
		Total Pathway Risk	3.9E-04
<u>Pathway: Ingestion</u>			
Benzo(a)anthracene	3.5E-08	1.2E+01	4.2E-07
Benzo(K)fluoranthene	4.2E-08	1.2E+01	5.0E-07
Benzo(a)pyrene	4.6E-08	1.2E+01	5.5E-07
Chrysene	1.2E-07	1.2E+01	1.4E-06
PCB 1262	1.5E-08	7.7E+00	1.2E-07
Pyrene	3.8E-07	1.2E+01	4.6E-06
Trichlorethylene	3.9E-07	1.1E-02	4.3E-09
		Total Pathway Risk	7.6E-06
		Total Site Risk	4.0E-04

<sup>a</sup>CDI = chronic daily intake.



*Table 5-2. Surface Soil Risk Characterization: Carcinogenic Effects  
Average Exposure Level  
Current Use On-Site Industrial Sites/SWMUs 17, 29, 32*

Chemical	CDI <sup>(a)</sup> (mg/kg/day)	Adjusted Oral Slope Factor (mg/kg/day) <sup>-1</sup>	Chemical-Specific Risk
<u>Pathway: Dermal Exposure</u>			
Benzo(a)anthracene	1.5E-06	1.2+01	1.8E-05
Benzo(k)fluoranthene	2.2E-06	1.2E+01	2.6E-05
Benzo(a)pyrene	2.0E-06	1.3E+01	2.0E-06
Chrysene	3.3E-06	1.2E+01	4.0E-06
PCB 1262	3.0E-07	8.5E+00	2.6E-06
Pyrene	1.3E-05	1.2E+01	1.6E-04
Trichloroethylene	2.0E-07	1.2E-02	2.4E-09
		Total Pathway Risk	2.1E-04
<u>Pathway: Ingestion</u>			
Benzo(a)anthracene	2.9E-08	1.2E+01	3.5E-07
Benzo(K)fluoranthene	4.2E-08	1.2E+01	5.0E-07
Benzo(a)pyrene	3.9E-08	1.2E+01	4.7E-07
Chrysene	6.3E-08	1.2E+01	7.6E-07
PCB 1262	6.4E-09	7.7E+00	4.9E-08
Pyrene	2.0E-07	1.2E+01	2.4E-06
Trichlorethylene	3.9E-07	1.1E-02	4.3E-09
		Total Pathway Risk	4.5E-06
		Total Site Risk	2.1E-04

<sup>a</sup>CDI = chronic daily intake.

*Table 5-3. Inhalation Risk Characterization: Carcinogenic Effects  
Reasonable Maximum Exposure Level  
Current Use On-Site Industrial Sites/SWMUs 17, 29, 30, 32*

Chemical	CDI <sup>(a)</sup> (mg/kg-day)	Inhalation Slope Factor (mg/kg-day) <sup>-1</sup>	Chemical-Specific Risk
Benzo(a)anthracene	1.4E-12	6.1E+00	8.7E-12
Benzo(a)pyrene	1.6E-10	6.1E-00	9.7E-10
Benzo(k)fluoranthene	2.0E-15	6.1E+00	1.2E-14
Carbon tetrachloride	2.0E-07	1.3E-01	2.6E-08
Chrysene	3.4E-14	6.1E+00	2.0E-13
Pyrene	7.1E-13	6.1E+00	4.4E-12
Tetrachloroethylene	2.0E-07	2.0E-03	4.1E-10
Trichloroethylene	1.6E-09	6.0E-03	9.6E-12
Total Pathway Risk			2.8E-08

<sup>a</sup>CDI = chronic daily intake.

*Table 5-4. Surface Soil Risk Characterization: Carcinogenic Effects  
Current Use On-Site Worker Site/SWMU 1*

Chemical	CDI <sup>(a)</sup> (mg/kg/day)	Adjusted Oral Slope Factor (mg/kg/day) <sup>-1</sup>	Chemical-Specific Risk
<u>Pathway: Dermal Exposure</u>			
2,4,6-Trinitrotoluene	1.9E-04	3.1E-02	5.9E-06
2,4-Dinitrotoluene	4.5E-06	7.2E-01	3.2E-06
2,6-Dinitrotoluene	4.2E-06	6.5E-01	<u>2.7E-06</u>
		Total Pathway Risk	1.2E-05
<u>Pathway: Ingestion</u>			
2,4,6-Trinitrotoluene	3.6E-06	3.0E-02	1.1 E-07
2,4-Dinitrotoluene	8.4E-08	6.8E-01	5.7 E-08
2,6-Dinitrotoluene	7.7E-08	6.8E-01	<u>5.2 E-08</u>
		Total Pathway Risk	2.3E-07
		Total Site Risk	1.2E-05

<sup>a</sup>CDI = chronic daily intake.

*Table 5-5. Groundwater Risk Characterization: Carcinogenic Effects  
Current Off-Site Residential (Well 12)  
Sites/SWMUs 2/30, 12/14/15, 29*

Chemical	CDI <sup>(a)</sup> (mg/kg/day)	Oral Slope Factor (mg/kg/day)	Chemical-Specific Risk
<u>Pathway: Ingestion</u>			
Beryllium	7.44E-08	4.3E+0	3.2E-07
Bis(2-ethylhexyl)phthalate	1.56E-06	1.4E-02	1.6E-08
Carbon Tetrachloride	1.19E-07	1.30E-01	1.5E-08
Cyclonite (RDX)	7.44E-08	1.10E-01	8.2E-09
Trichloroethylene	7.14E-07	1.10E-01	<u>7.8E-08</u>
Total Pathway Risk			4.4E-07

<sup>a</sup>CDI = chronic daily intake.

#### **5.1.1.4 On-Site Residential**

The carcinogenic risk for on-site residential (administrative area) exposure (RME) through inhalation is  $1.3 \text{ E}^{-06}$  (see Table 5-7).

#### **5.1.1.5 Cities of Grantsville, Tooele, Stockton**

The risk characterization for inhalation of site-related volatiles by residents of Grantsville, Tooele, and Stockton is presented in Tables 5-8, 5-9, and 5-10, respectively. The total pathway risk for Grantsville is  $3.1 \text{ E}^{-05}$ , for Tooele is  $3.8 \text{ E}^{-05}$ , and for Stockton is  $8.9 \text{ E}^{-06}$ . Virtually all of the potential risk is due to estimated TCE releases from an air stripper that is currently being constructed at TEAD-N for the treatment of TCE-contaminated groundwater.

#### **5.1.1.6 On-Site Worker/Local Resident**

An indication of maximum-potential cumulative risk can be obtained for an individual who is both an on-site worker and an off-site resident. The maximum risk for an on-site worker (in the industrial area) is  $3.9 \text{ E}^{-04}$ , and the maximum risk for an off-site resident (city of Tooele) is  $3.8 \text{ E}^{-05}$ , for a total of  $4.3 \text{ E}^{-04}$ . Essentially all of the risk is due to on-site worker exposure.

### **5.1.2 Non-Carcinogens**

#### **5.1.2.1 On-Site Industrial Worker**

Risk characterization for on-site industrial-worker soil ingestion and dermal-absorption exposure routes are presented in Tables 5-11 and 5-12. The total pathway hazard indices for dermal exposure to site soils are  $1.9 \text{ E}^{-02}$  (RME) and  $9.3 \text{ E}^{-03}$  (average exposure); for soil ingestion they are  $8 \text{ E}^{-03}$  (RME) and  $3.8 \text{ E}^{-03}$  (average exposure). The total hazard indices are  $2.7 \text{ E}^{-02}$  (RME) and  $1.3 \text{ E}^{-02}$  (average exposure) for surface-soil exposure. The pathway hazard index calculated for inhalation of volatiles is  $1.6 \text{ E}^{-05}$  (see Table 5-13).

Non-carcinogenic hazard estimates for school personnel in the administrative area were not calculated. These hazard estimates would be less than hazard estimates for on-site industrial workers, for whom health effects were not a concern, because of lower exposure frequency, shorter duration, and greater distance from the source.

*Table 5-6. Groundwater Risk Characterization: Carcinogenic Effects  
Current Use Off-Site Residential (Well OY) Sites/SWMUs 10/11*

Chemical	CDI <sup>(a)</sup> (mg/kg-day)	Oral Slope Factor (mg/kg-day) <sup>-1</sup>	Chemical-Specific Risk
Arsenic	2.9 E-07	1.75 E+00	5.1 E-07
Cyclonite (RDX)	3.4 E-07	1.1 E-01	3.7 E-08
2,4-Dinitrotoluene	7.4 E-08	6.8 E-03	5.0 E-08
2,4,6-Trinitrotoluene	7.4 E-08	3.0 E-02	2.2 E-09
Total Pathway Risk			6.0 E-07

<sup>a</sup>CDI = chronic daily intake.

*Table 5-7. Inhalation Risk Characterization: Carcinogenic Effects  
Reasonable Maximum Exposure  
Current Use On-Site Residential*

<b>Chemical</b>	<b>CDI<sup>(a)</sup> (mg/kg-day)</b>	<b>Inhalation Slope Factor (mg/kg-day)<sup>-1</sup></b>	<b>Chemical-Specific Risk</b>
Benzo(a)anthracene	9.0 E-13	6.1 E+00	5.5 E-12
Benzo(a)pyrene	1.1 E-10	6.1 E+00	6.6 E-10
Benzo(k)fluoranthene	1.3 E-15	6.1 E+00	8.4 E-15
Carbon tetrachloride	4.1 E-08	1.3 E-01	5.3 E-09
Chrysene	2.2 E-14	6.1 E+00	1.3 E-13
Pyrene	4.6 E-13	6.1 E+00	2.8 E-12
Tetrachloroethylene	4.1 E-08	2.0 E-03	8.4 E-11
Trichloroethylene	2.1 E-04	6.0 E-03	1.3 E-06
<b>Total Pathway Risk</b>			<b>1.3 E-06</b>

<sup>a</sup>CDI = chronic daily intake.

*Table 5-8. Inhalation Risk Characterization: Carcinogenic Effects  
Reasonable Maximum Exposure  
Current Use Off-Site Residential: Grantsville*

Chemical	CDI <sup>1</sup> (mg/kg-day)	Inhalation Slope Factor (mg/kg-day) <sup>-1</sup>	Chemical* Specific Risk
Benzo(a)anthracene	1.4 E-11	6.1 E+00	8.8 E-11
Benzo(a)pyrene	1.4 E-10	6.1 E+00	8.8 E-10
Benzo(k)fluoranthene	3.0 E-15	6.1 E+00	1.8 E-14
Carbon tetrachloride	3.9 E-07	1.3 E-01	5.0 E-08
Chrysene	4.8 E-14	6.1 E+00	2.9 E-13
Pyrene	9.3 E-13	6.1 E+00	5.7 E-12
Tetrachloroethylene	3.9 E-07	2.0 E-03	7.8 E-10
Trichloroethylene	5.2 E-03	6.0 E-03	3.1 E-05
Total Pathway Risk			3.1 E-05

<sup>1</sup>CDI = chronic daily intake.

\* Based on incomplete scrubber-stack information, the final risk analysis is expected to demonstrate a lower risk than reported here.



*Table 5-9. Inhalation Risk Characterization: Carcinogenic Effects  
Reasonable Maximum Exposure  
Current Use Off-Site Residential: Tooele*

Chemical	CDI <sup>†</sup> (mg/kg-day)	Inhalation Slope Factor (mg/kg-day) <sup>-1</sup>	Chemical* Specific Risk
Benzo(a)anthracene	1.2 E-11	6.1 E+00	7.5 E-11
Benzo(a)pyrene	1.2 E-09	6.1 E+00	7.3 E-09
Benzo(k)fluoranthene	2.6 E-15	6.1 E+00	1.6 E-13
Carbon tetrachloride	1.4 E-06	1.3 E-01	1.9 E-07
Chrysene	4.0 E-13	6.1 E+00	2.5 E-12
Pyrene	7.5 E-12	6.1 E+00	4.5 E-11
Tetrachloroethylene	1.4 E-06	2.0 E-03	2.9 E-09
Trichloroethylene	6.3 E-03	6.0 E-03	3.8 E-05
Total Pathway Risk			3.8 E-05

<sup>†</sup>CDI = chronic daily intake.

\* Based on incomplete scrubber-stack information, the final risk analysis is expected to demonstrate a lower risk than reported here.

*Table 5-10. Inhalation Risk Characterization: Carcinogenic Effects  
Reasonable Maximum Exposure  
Current Use Off-Site Residential: Stockton*

Chemical	CDI <sup>†</sup> (mg/kg-day)	Inhalation Slope Factor (mg/kg-day) <sup>-1</sup>	Chemical* Specific Risk
Benzo(a)anthracene	2.1 E-12	6.1 E+00	1.3 E-11
Benzo(a)pyrene	2.0 E-10	6.1 E+00	1.2 E-09
Benzo(k)fluoranthene	4.3 E-15	6.1 E+00	2.6 E-14
Carbon tetrachloride	2.5 E-07	1.3 E-01	3.3 E-08
Chrysene	6.7 E-14	6.1 E+00	4.1 E-13
Pyrene	1.3 E-12	6.1 E+00	8.0 E-12
Tetrachloroethylene	2.6 E-07	2.0 E-03	5.1 E-10
Trichloroethylene	1.5 E-03	6.0 E-03	8.9 E-06
Total Pathway Risk			8.9 E-06

<sup>†</sup>CDI = chronic daily intake.

\* Based on incomplete scrubber-stack information, the final risk analysis is expected to demonstrate a lower risk than reported here.

*Table 5-11. Surface Soil Risk Characterization: Noncarcinogenic Effects  
Reasonable Maximum Exposure  
Current Use On-Site Industrial Sites/SWMUs 17, 29, 32*

<b>Chemical</b>	<b>CDI<sup>(a)</sup> (mg/kg/day)</b>	<b>Adjusted RfD<sup>(b)</sup> (mg/kg/day)</b>	<b>Hazard Quotient</b>
<b><u>Pathway: Dermal Exposure</u></b>			
Chromium	2.1E - 06	1.0E - 03	2.1E - 03
Nickel	5.2E - 06	1.0E - 03	5.2E - 03
Zinc	6.6E - 05	1.0E - 02	6.6E - 03
Fluoranthene	1.6E - 05	3.8E - 02	4.1E - 04
Pyrene	1.4E - 04	2.9E - 02	<u>4.8E - 03</u>
		<b>Total Pathway Hazard</b>	<b>2.1E - 02</b>
<b><u>Pathway: Ingestion</u></b>			
Chromium	1.7E - 05	5.0E - 03	3.3E - 03
Nickel	4.1E - 05	2.0E - 02	2.0E - 03
Zinc	5.2E - 04	2.0E - 01	2.6E - 03
Fluoranthene	3.1E - 07	4.0E - 02	7.6E - 06
Pyrene	2.7E - 06	3.0E - 02	<u>9.0E - 05</u>
		<b>Total Pathway Hazard</b>	<b>8.0E - 03</b>
		<b>Total Site Hazard</b>	<b>2.7E - 02</b>

<sup>a</sup>CDI = chronic daily intake.

<sup>b</sup>RfD = reference dose.

*Table 5-12. Surface Soil Risk Characterization: Noncarcinogenic Effects  
Average Exposure  
Current Use On-Site Industrial Sites/SWMUs 17, 29, 32*

Chemical	CDI <sup>(a)</sup> (mg/kg/day)	Adjusted RfD <sup>(b)</sup> (mg/kd/day)	Hazard Quotient
<u>Pathway: Dermal Exposure</u>			
Chromium	1.3E - 06	1.0E - 03	1.3E - 03
Nickel	7.6E - 07	1.0E - 03	7.6E - 04
Zinc	3.6E - 05	1.0E - 02	3.6E - 03
Fluoranthene	1.6E - 05	3.8E - 02	4.1E - 04
Pyrene	9.0E - 05	2.8E - 02	<u>3.2E - 03</u>
Total Pathway Hazard			9.3E - 03
<u>Pathway: Ingestion</u>			
Chromium	1.0E - 05	5.0E - 03	2.0E - 03
Nickel	6.0E - 06	2.0E - 02	3.0E - 04
Zinc	2.8E - 04	2.0E - 01	1.4E - 03
Fluoranthene	3.1E - 07	4.0E - 02	7.6E - 06
Pyrene	1.8E - 06	3.0E - 02	<u>5.8E - 05</u>
Total Pathway Hazard			3.8E - 03
Total Site Hazard			1.3E - 02

<sup>a</sup>CDI = chronic daily intake.

<sup>b</sup>RfD = reference dose.

*Table 5-13. Inhalation Risk Characterization: Noncarcinogenic Effects  
Current Use On-Site Industrial Sites/SWMUs 30, 17, 29, 32*

Chemical	CDI <sup>(a)</sup> (mg/kg-day)	Inhalation RfD <sup>(b)</sup> (mg/kg-day)	Hazard Quotient
Ethylbenzene	4.6 E-08	3 E-01	1.5 E-07
Toluene	1.2 E-06	6 E-01	2.0 E-06
1,1,1-Trichloroethane	4.1 E-06	3 E-01	1.4 E-05
Total Pathway Hazard Index			1.6 E-05

<sup>a</sup>CDI = chronic daily intake.

<sup>b</sup>RfD = reference dose.

#### **5.1.2.2      *Site-Specific Worker***

The total non-carcinogenic hazard to workers from exposure to soils at Site/SWMU 1 is  $2.7 \text{ E}^{+00}$  (see Table 5-14). The hazard index for the dermal pathway is  $2.7 \text{ E}^{+00}$ , and for soil ingestion it is  $5.2 \text{ E}^{-02}$ . A hazard index cannot be calculated for inhalation of volatiles due to a lack of reference doses for the chemicals of concern.

Sites/SWMUs 3, 7, and 10/11 are not active under current land use.

#### **5.1.2.3      *Off-Site Resident***

There is no available reference dose for nitrate, which is the only chemical of concern modeled for exposure of off-site residential receptors at Wells 10 and 16. Therefore, no hazard could be calculated.

The total hazard index for off-site residential ingestion of groundwater from Well 12—influenced by Sites/SWMUs 2/30, 12/14/15, and 29—is  $1.7 \text{ E}^{-02}$  (see Table 5-15).

The total non-carcinogenic hazard from off-site ingestion of groundwater from Well OY, if influenced by Sites/SWMUs 10/11, is  $2.5 \text{ E}^{-02}$  (see Table 5-16).

#### **5.1.2.4      *On-Site Resident***

The total non-carcinogenic hazard for exposure (RME) through inhalation of volatiles is  $9.3 \text{ E}^{-06}$  (see Table 5-17).

#### **5.1.2.5      *Cities of Grantsville, Tooele, and Stockton***

The risk characterization for inhalation of volatiles by residents of Grantsville, the City of Tooele, and Stockton is presented in Tables 5-18, 5-19, and 5-20, respectively. The total pathway hazard index for Grantsville is  $1.0 \text{ E}^{-05}$ , while that for the City of Tooele is  $3.7 \text{ E}^{-05}$ . The total hazard index calculated for residents of Stockton is  $6.6 \text{ E}^{-06}$ .

#### **5.1.2.6      *On-Site Worker/Local Resident***

The maximum-potential cumulative non-carcinogenic hazard for an individual who is both an on-site worker and an off-site resident is  $2.7 \text{ E}^{+00}$ , which is due entirely to on-site-worker exposure at Site/SWMU 1. Maximum noncarcinogenic hazard for an off-site resident is  $2.5 \text{ E}^{-02}$ , due to consumption of water from Well OY.

*Table 5-14. Surface Soil Risk Characterization: Noncarcinogenic Effects  
Current Use On-Site Worker Site/SWMU 1*

Chemical	CDI <sup>(a)</sup> (mg/kg/day)	RfD <sup>(b)</sup> (mg/kg/day)	Hazard Quotient
<u>Pathway: Dermal Exposure</u>			
Barium	2.0E - 06	3.5E - 03	5.7E - 04
Cadmium	4.5E - 08	4.0E - 05	1.1E - 03
2,4,6-Trinitrotoluene	1.3E - 03	4.8E - 04	<u>2.7E+00</u>
Total Pathway Hazard			2.7E+00
<u>Pathway: Ingestion</u>			
Barium	1.5E - 05	7.0E - 02	2.1E - 04
Cadmium	3.2E - 07	5.0E - 04	6.4E - 04
2,4,6-Trinitrotoluene	2.5E - 05	5.0E - 04	<u>5.1E - 02</u>
Total Pathway Hazard			5.2E - 02
Total Pathway Hazard Index			2.7E+00

<sup>a</sup>CDI = chronic daily intake.

<sup>b</sup>RfD = reference dose.

*Table 5-15. Groundwater Risk Characterization: Noncarcinogenic Effects  
Current Off-Site Residential (Well 12)  
Sites/SWMUs 30, 12/14/15, 29*

Chemical	CDI <sup>(a)</sup> (mg/kg/day)	RfD <sup>(b)</sup> (mg/kg/day)	Hazard Quotient
<u>Pathway: Ingestion</u>			
Beryllium	1.74 E-07	5.0 E-03	3.8 E-05
Cadmium	6.94 E-08	5.0 E-04	1.4 E-04
Chromium	4.62 E-06	5.0 E-03	9.2 E-04
Copper	2.4 E-07	3.7 E-02	6.6 E-06
Manganese	3.68 E-05	1.0 E-01	3.7 E-04
Nickel	1.35 E-06	2.0 E-02	6.8 E-05
Bis(2-ethylhexyl)phthalate	3.64 E-06	2.00 E-02	1.8 E-04
Carbon tetrachloride	2.78 E-07	7.0 E-04	4.0 E-04
Cyclonite (RDX)	1.74 E-07	3.0 E-03	5.8 E-05
1,1,1-Trichloroethane	1.39 E-06	9.0 E-02	1.5 E-02
Total Pathway Hazard Index			1.7 E-02

<sup>a</sup>CDI = chronic daily intake.

<sup>b</sup>RfD = reference dose.



*Table 5-16. Groundwater Risk Characterization: Noncarcinogenic Effects  
Current Use Off-Site Residential (Well OY) Sites/SWMUs 10/11*

Chemical	CDI <sup>(a)</sup> (mg/kg/day)	RfD <sup>(b)</sup> (mg/kg/day)	Hazard Quotient
<u>Pathway: Ingestion</u>			
Arsenic	5.9 E-08	3.0 E-04	1.9 E-04
Copper	1.7 E-07	3.7 E-02	4.6 E-06
Fluoride	3.2 E-06	6.0 E-02	5.4 E-05
Thallium	1.7 E-07	7.0 E-05	2.4 E-02
2,4,6-Trinitrotoluene	1.7 E-07	5.0 E-04	3.4 E-04
Total Pathway Hazard Index			2.5 E-02

<sup>a</sup>CDI = chronic daily intake.

<sup>b</sup>RfD = reference dose.

*Table 5-17. Inhalation Risk Characterization: Noncarcinogenic Effects  
Reasonable Maximum Exposure  
Current Use On-Site Residential*

Chemical	CDI <sup>(a)</sup> (mg/kg-day)	Inhalation RfD <sup>(b)</sup> (mg/kg/day)	Hazard Quotient
Ethylbenzene	2.7 E-08	3.0 E-01	9.0 E-08
Toluene	7.1 E-07	6.0 E-1	1.2 E-06
1,1,1-Trichloroethane	2.4 E-06	3.0 E-1	8.0 E-06
Total Pathway Hazard Index			9.3 E-06

<sup>a</sup>CDI = chronic daily intake.

<sup>b</sup>RfD = reference dose.

*Table 5-18. Inhalation Risk Characterization: Noncarcinogenic Effects  
Current Use Off-Site Residential: Grantsville*

<b>Chemical</b>	<b>CDI<sup>(a)</sup> (mg/kg-day)</b>	<b>Inhalation RfD<sup>(b)</sup> (mg/kg-day)<sup>-1</sup></b>	<b>Hazard Quotient</b>
Ethylbenzene	2.9 E-08	3 E-1	1.0 E-07
Toluene	7.7 E-07	6 E-1	1.3 E-06
1,1,1-Trichloroethane	2.6 E-06	3 E-1	8.7 E-06
<b>Total Pathway Hazard Index</b>			<b>1.0 E-05</b>

<sup>a</sup>CDI = chronic daily intake.

<sup>b</sup>RfD = reference dose.

*Table 5-19. Inhalation Risk Characterization: Noncarcinogenic Effects  
Current Use Off-Site Residential: Tooele*

Chemical	CDI <sup>(a)</sup> (mg/kg-day)	Inhalation RfD <sup>(b)</sup> (mg/kg-day)	Hazard Quotient
Ethylbenzene	1.1 E-07	3 E-1	3.7 E-07
Toluene	2.8 E-06	6 E-1	4.7 E-06
1,1,1-Trichloroethane	9.6 E-06	3 E-1	3.2 E-05
Total Pathway Hazard Index			3.7 E-05

<sup>a</sup>CDI = chronic daily intake.

<sup>b</sup>RfD = reference dose.

*Table 5-20. Inhalation Risk Characterization: Noncarcinogenic Effects  
Current Use Off-Site Residential: Stockton*

Chemical	CDI <sup>(a)</sup> (mg/kg-day)	Inhalation RfD <sup>(b)</sup> (mg/kg-day)	Hazard Quotient
Ethylbenzene	1.9 E-08	3 E-01	6.6 E-08
Toluene	5.0 E-07	6 E-01	8.3 E-07
1,1,1-Trichloroethane	1.7 E-06	3 E-01	5.7 E-06
Total Pathway Hazard Index			6.6 E-06

<sup>a</sup>CDI = chronic daily intake.

<sup>b</sup>RfD = reference dose.

## 5.2 FUTURE LAND USE

### 5.2.1 Carcinogens

#### 5.2.1.1 *On-Site Industrial Worker*

Potential risks posed to on-site industrial workers under the future-land-use scenario are the same as those presented in Section 5.1.1 for current land use.

#### 5.2.1.2 *On-Site Resident*

The risks from exposure to soil in the industrial area for hypothetical future residents are  $1.1 \text{ E}^{-03}$  RME and  $1.4 \text{ E}^{-04}$  average exposure (see Tables 5-21 and 5-22). The risks from the groundwater pathway are  $6.1 \text{ E}^{-03}$  RME and  $2.1 \text{ E}^{-04}$  average exposure (see Tables 5-23 through 5-24), and the risk from the inhalation pathway is  $5.7 \text{ E}^{-10}$  (see Table 5-25).

The total carcinogenic risk associated with future hypothetical residential exposure to surface soils at Site/SWMU 1 is  $1 \text{ E}^{-04}$  (see Table 5-26). The risk calculated for dermal exposure to soils is  $1.2 \text{ E}^{-04}$ , and that for ingestion is  $4.9 \text{ E}^{-06}$ . For both pathways, dinitrotoluenes and trinitrotoluenes are approximately equal contributors to the risk. There are no oral-slope factors for chemicals of concern in groundwater or for volatilized chemicals released from soils at this site; therefore, risks could not be estimated.

At Site/SWMU 2 the total carcinogenic risks from groundwater ingestion are  $8.8 \text{ E}^{-05}$  (RME) and  $8.0 \text{ E}^{-06}$  average exposure (see Tables 5-27 and 5-28). No soil or inhalation pathway is complete.

Slope factors are not available for chemicals of potential concern found in soils at Site/SWMU 3; therefore, surface-soil risks could not be calculated.

The total carcinogenic risk from exposure to surface soils at Site/SWMU 7 for hypothetical future residents is  $7.5 \text{ E}^{-06}$  (see Table 5-29), including the dermal route ( $4.1 \text{ E}^{-06}$ ) and ingestion route ( $3.4 \text{ E}^{-06}$ ). In both pathways, all of the estimated risk is from beryllium.

The risk characterization from exposure to soil at Sites/SWMUs 10/11 is presented in Table 5-30. The risk for the dermal route of exposure is  $2.4 \text{ E}^{-02}$ , with 2,4,6-trinitrotoluene contributing most of the risk. For ingestion, the total pathway risk is  $9.9 \text{ E}^{-04}$ , with 2,4,6-trinitrotoluene the major contributor to risk. The total site risk from exposure to soils through both pathways is  $2.5 \text{ E}^{-02}$ . The total pathway risk for groundwater ingestion at this location is  $3.3 \text{ E}^{-03}$  (see Table 5-31). Three chemicals—arsenic, RDX, and 2,4-dinitrophenol—showed the highest chemical specific risks. No slope factors were available for chemicals of concern volatilized from site soils; therefore, no risks could be calculated for the inhalation pathway.

*Table 5-21. Surface Soil Risk Characterization: Carcinogenic Effects  
Reasonable Maximum Exposure Future On-Site Residential  
Sites/SWMUs 12,14,15,29,30 (Industrial Area)*

Chemical	CDI <sup>(a)</sup> (mg/kg/day)	Oral Slope Factor (mg/kd/day) <sup>-1</sup>	Chemical Specific Risk
<u>Pathway: Dermal Exposure</u>			
Benzo(a)anthracene	1.3E - 05	1.2E + 01	1.6E - 04
Benzo(k)fluoranthene	1.5E - 05	1.2E + 01	1.9E - 04
Benzo(a)pyrene	1.4E - 05	1.3E + 01	1.9E - 04
Chrysene	4.2E - 05	1.2E + 01	5.1E - 04
Pyrene	1.4E - 04	1.2E + 01	1.7E - 09
Total Pathway Risk			1.1E - 03
<u>Pathway: Ingestion</u>			
Benzo(a)anthracene	8.0E - 07	1.2E + 01	9.2E - 06
Benzo(k)fluoranthene	9.6E - 07	1.2E + 01	1.1E - 05
Benzo(a)pyrene	8.8E - 07	1.2E + 01	1.0E - 05
Chrysene	2.6E - 06	1.2E + 01	3.0E - 05
Pyrene	8.6E - 06	1.2E + 01	9.9E - 05
Total Pathway Risk			2.0E - 04
Total Site Risk			1.3E - 03

<sup>a</sup>CDI = chronic daily intake.

*Table 5-22. Surface Soil Risk Characterization: Carcinogenic Effects  
Average Exposure Future On-Site Residential  
Sites/SWMUs 12,14,15,29,30 (Industrial Area)*

Chemical	CDI <sup>(a)</sup> (mg/kg/day)	Oral Slope Factor (mg/kd/day) <sup>-1</sup>	Chemical Specific Risk
<u>Pathway: Dermal Exposure</u>			
Benzo(a)anthracene	1.9E - 06	1.2E + 01	2.3E - 05
Benzo(k)fluoranthene	2.8E - 06	1.2E + 01	3.3E - 05
Benzo(a)pyrene	2.5E - 06	1.3E + 01	3.3E - 05
Chrysene	4.1E - 06	1.2E + 01	5.0E - 05
Pyrene	1.6E - 05	1.2E + 01	<u>1.9E - 04</u>
		Total Pathway Risk	3.3E - 04
<u>Pathway: Ingestion</u>			
Benzo(a)anthracene	7.39E - 08	1.2E + 01	8.5E - 07
Benzo(k)fluoranthene	1.06E - 07	1.2E + 01	1.2E - 06
Benzo(a)pyrene	9.68E - 08	1.2E + 01	1.1E - 06
Chrysene	1.6E - 07	1.2E + 01	1.8E - 06
Pyrene	6.2E - 07	1.2E + 01	7.1E - 06
		Total Pathway Risk	1.2E - 05
		Total Site Risk	3.4E - 04

<sup>a</sup>CDI = chronic daily intake.



*Table 5-23. Groundwater Risk Characterization: Carcinogenic Effects  
Reasonable Maximum Exposure Future On-Site Residential  
Sites/SWMUs 12,14,15,29,30 (Industrial Area)*

Chemical	CDI <sup>(a)</sup> (mg/kg/day)	Oral Slope Factor (mg/kg/day) <sup>-1</sup>	Chemical Specific Risk
Arsenic	3.3 E-04	1.8 E+01	5.7 E-03
Beryllium	2.4 E-05	4.3 E+00	1.0 E-04
Benzene	1.2 E-05	2.9 E-02	3.5 E-07
Bis-(2-ethylhexyl)phthalate	1.2 E-02	1.4 E-02	1.6 E-04
Carbon tetrachloride	6.1 E-04	1.3 E-01	7.9 E-05
Chloroform	7.5 E-05	6.1 E-03	4.5 E-07
Trichloroethylene	2.1 E-03	1.1 E-02	2.3 E-05
Total Pathway Risk			6.1 E-03

<sup>a</sup>CDI = chronic daily intake.

*Table 5-24. Groundwater Risk Characterization: Carcinogenic Effects  
Average Exposure Future On-Site Residential  
Sites/SWMUs 12,14,15,29,30 (Industrial Area)*

Chemical	CDI <sup>(a)</sup> (mg/kg/day)	Oral Slope Factor (mg/kg/day) <sup>-1</sup>	Chemical Specific Risk
Arsenic	1.2 E-05	1.8 E+01	2.1 E-04
Beryllium	3.5 E-07	4.3 E+00	1.5 E-06
Benzene	1.3 E-06	2.9 E-02	3.7 E-08
Bis-(2-ethylhexyl)phthalate	1.5 E-04	1.4 E-02	2.1 E-06
Carbon tetrachloride	1.1 E-05	1.3 E-01	1.4 E-06
Chloroform	4.9 E-06	6.1 E-03	3.0 E-08
Trichloroethylene	5.8 E-06	1.1 E-02	6.4 E-08
Total Pathway Risk			2.2 E-04

<sup>a</sup>CDI = chronic daily intake.

*Table 5-25. Inhalation Risk Characterization: Carcinogenic Effects  
Reasonable Maximum Exposure  
Future On-Site Residential Site/SWMU 29 (Industrial Area)*

<b>Chemical</b>	<b>CDI<sup>(a)</sup> (mg/kg-day)</b>	<b>Inhalation Slope Factor (mg/kg/day)<sup>-1</sup></b>	<b>Chemical Specific Risk</b>
Benzo(a)anthracene	9.5 E-13	6.1 E+00	5.8 E-12
Benzo(a)pyrene	9.2 E-11	6.1 E+00	5.6 E-10
Benzo(k)fluoranthene	2.0 E-15	6.1 E+00	1.2 E-14
Chrysene	3.1 E-14	6.1 E+00	1.9 E-13
Pyrene	6.0 E-13	6.1 E+00	3.7 E-12
<b>Total Pathway Risk</b>			<b>5.7 E-10</b>

<sup>a</sup>CDI = chronic daily intake.

*Table 5-26. Surface Soil Risk Characterization: Carcinogenic Effects  
Future On-Site Residential Site/SWMU 1*

Chemical	CDI <sup>(a)</sup> (mg/kg/day)	Oral Slope Factor (mg/kg/day) <sup>-1</sup>	Chemical Specific Risk
<u>Pathway: Dermal Exposure</u>			
2,4,6-Trinitrotoluene	1.3E - 03	3.1E - 02	4.0E - 05
2,4-Dinitrotoluene	3.0E - 05	1.4E + 00	4.2E - 05
2,6-Dinitrotoluene	2.5E - 05	1.4E + 00	<u>3.5E - 05</u>
		Total Pathway Risk	1.2E - 04
<u>Pathway: Ingestion</u>			
2,4,6-Trinitrotoluene	8.2E - 05	3.0E - 02	2.4E - 06
2,4-Dinitrotoluene	1.9E - 06	6.8E - 01	1.3E - 06
2,6-Dinitrotoluene	1.7E - 06	6.8E - 01	<u>1.2E - 06</u>
		Total Pathway Risk	4.9E - 06
		Total Site Risk	1.2E - 04

<sup>a</sup>CDI = chronic daily intake.

*Table 5-27. Groundwater Risk Characterization: Carcinogenic Effects  
Reasonable Maximum Exposure  
Future On-Site Residential Site/SWMU 2*

Chemical	CDI <sup>(a)</sup> (mg/kg/day)	Oral Slope Factor (mg/kg/day) <sup>-1</sup>	Chemical Specific Risk
Arsenic	4.5 E-05	1.8 E-01	7.8 E-06
Carbon tetrachloride	3.0 E-04	1.3 E-01	3.9 E-05
1,4-Dichlorobenzene	6.0 E-06	2.4 E-02	1.4 E-07
Tetrachloroethylene	4.5 E-06	5.1 E-02	2.3 E-07
Trichloroethylene	3.7 E-03	1.1 E-02	4.1 E-05
Total Pathway Risk			8.8 E-05

<sup>a</sup>CDI = chronic daily intake.

*Table 5-28. Groundwater Risk Characterization: Carcinogenic Effects  
Average Exposure  
Future On-Site Residential Site/SWMU 2*

Chemical	CDI <sup>(a)</sup> (mg/kg/day)	Oral Slope Factor (mg/kg/day) <sup>-1</sup>	Chemical Specific Risk
Arsenic	8.1 E-06	1.8 E-01	1.4 E-06
Carbon tetrachloride	2.5 E-05	1.3 E-01	3.2 E-06
1,4-Dichlorobenzene	9.8 E-07	2.4 E-02	2.4 E-08
Tetrachloroethylene	4.9 E-07	5.1 E-02	2.5 E-08
Trichloroethylene	3.1 E-04	1.1 E-02	3.4 E-06
Total Pathway Risk			8.0 E-06

<sup>a</sup>CDI = chronic daily intake.

*Table 5-29. Surface Soil Risk Characterization: Carcinogenic Effects  
Future On-Site Residential Site/SWMU 7*

Chemical	CDI <sup>(a)</sup> (mg/kg/day)	Oral Slope Factor (mg/kg/day) <sup>-1</sup>	Chemical Specific Risk
<u>Pathway: Dermal Exposure</u>			
Beryllium	4.8E - 08	8.6E + 01	<u>4.1E - 06</u>
		Total Pathway Risk	4.1E - 06
<u>Pathway: Ingestion</u>			
Beryllium	8.0E - 07	4.3E + 00	<u>3.4E - 06</u>
		Total Pathway Risk	3.4E - 06
		Total Site Risk	7.5E - 06

<sup>a</sup>CDI = chronic daily intake.

*Table 5-30. Surface Soil Risk Characterization: Carcinogenic Effects  
Future On-Site Residential Sites/SWMUs 10/11*

Chemical	CDI <sup>(a)</sup> (mg/kg/day)	Oral Slope Factor (mg/kg/day) <sup>-1</sup>	Chemical Specific Risk
<u>Pathway: Dermal Exposure</u>			
2,4,6-Trinitrotoluene	7.8E - 01	3.1E - 02	2.4E - 02
2,4-Dinitrotoluene	3.1E - 04	7.2E - 01	<u>2.2E - 04</u>
Total Pathway Risk			2.4E - 02
<u>Pathway: Ingestion</u>			
2,4,6-Trinitrotoluene	3.3E - 02	3.0E - 02	9.8E - 04
2,4-Dinitrotoluene	1.3E - 05	6.8E - 01	<u>8.8E - 06</u>
Total Pathway Risk			9.9E - 04
Total Site Risk:			2.5E - 02

<sup>a</sup>CDI = chronic daily intake.



*Table 5-31. Groundwater Risk Characterization: Carcinogenic Effects  
Future On-Site Residential Sites/SWMUs 10/11*

Chemical	CDI <sup>(a)</sup> (mg/kg/day)	Oral Slope Factor (mg/kg/day) <sup>-1</sup>	Chemical Specific Risk
Pathway: Ingestion			
Arsenic	1.6E-03	1.75E+00	2.8E-03
Bis(2-ethylhexyl)phthalate	1.49E-04	1.4E-02	2.1E-06
Chloroform	2.97E-05	6.1E-03	1.8E-07
Cyclonite(RDX)	2.38E-03	1.1E-01	2.6E-04
2,4-Dinitrophenol	2.97E-04	6.8E-01	2.0E-04
2,4,6-Trinitrotoluene	5.56E-04	3.0E-02	1.7E-05
Total Pathway Risk			3.3E-03

<sup>a</sup>CDI = chronic daily intake.

## 5.2.2 Non-Carcinogens

### 5.2.2.1 *On-Site Industrial Worker*

The noncarcinogenic hazard for future industrial workers is the same as that for the current use scenario (see Section 5.1.2).

### 5.2.2.2 *On-Site Resident*

The risk characterization for exposure to surface soils by hypothetical future residents is shown in Tables 5-32 and 5-33. The total site hazards for soil pathways are  $4.4 \text{ E}^{-02}$  (RME) and  $1.3 \text{ E}^{-02}$  (average exposure). Hazards of  $1.4 \text{ E}^{+01}$  RME (Table 5-34) and  $1.0 \text{ E}^{+00}$  average exposure (Table 5-35) are opted for exposure to groundwater.

The risk characterization from exposure of hypothetical future residents to soils at 1 is presented in Table 5-36. The dermal and ingestion hazard indices are  $2.1 \text{ E}^{+01}$  and  $3.9 \text{ E}^{-01}$ , respectively. Inhalation reference doses were not available for the chemicals of potential concern; therefore, the hazard index for inhalation could not be calculated.

The risk characterization from exposure of hypothetical future residents to groundwater at 2 are  $4.9 \text{ E}^{+00}$  RME and  $3.7 \text{ E}^{-01}$  average exposure (see Tables 5-37 and 5-38). Soil and air pathways were not complete for this site/SWMU. Potential hazards from exposure to on-site surface soils at 3 are presented in Table 5-39. For dermal exposure and ingestion, the hazard is  $6.7 \text{ E}^{-03}$  and  $2.2 \text{ E}^{-02}$ , respectively.

The risk characterization for exposure to surface soils at 7 is presented in Table 5-40. The hazard is nearly the same for dermal exposure and ingestion ( $6.8$  and  $6.9 \text{ E}^{-02}$ , respectively), yielding a total hazard index of  $1.4 \text{ E}^{-01}$  for soil.

The sum of future residential non-carcinogenic hazards from surface-soil exposure at Sites/SWMUs 10/11 is  $4 \text{ E}^{+03}$ , including  $3.9 \text{ E}^{+03}$  from dermal absorption and  $1.5 \text{ E}^{+02}$  from ingestion (see Table 5-41). The non-carcinogenic hazards calculated for groundwater exposure at Sites/SWMUs 10/11 are presented in Table 5-42. The total hazard quotient calculated was  $2.1 \text{ E}^{+01}$ . This value is considerably above the value of unity, suggesting potential concern for adverse health effects from exposure to groundwater at this location. Fluoride and arsenic have the highest hazard quotients and appear to be primary contributors, with values of  $3.8 \text{ E}^{+0}$  and  $1.3 \text{ E}^{+01}$ , respectively. The chemical 2,4,6-trinitrotoluene shows a hazard quotient of  $2.6 \text{ E}^{+0}$ , and may also indicate potential concern. Another chemical with a hazard quotient above unity is thallium, with a value of  $1.7 \text{ E}^{+0}$ . The hazard quotient of these four chemicals combined comprise the majority of the pathway hazard. Reference doses were not available for the volatile chemicals of concern in soil; therefore, a hazard index for inhalation of volatiles could not be calculated.

*Table 5-32. Surface Soil Risk Characterization: Noncarcinogenic Effects  
Reasonable Maximum Exposure  
Future On-Site Residential  
Sites/SWMus 12, 14, 15, 29, 30 (Industrial Area)*

Chemical	CDI <sup>(a)</sup> (mg/kg/day)	Adjusted RfD <sup>(b)</sup> (mg/kg/day)	Hazard Quotient
<u>Pathway: Dermal Exposure</u>			
Cadmium	4.9E - 07	4.0E - 05	1.2E - 02
Chromium	5.0E - 06	1.0E - 03	5.0E - 03
Fluoranthene	3.7E - 05	3.8E - 02	9.7E - 04
Pyrene	3.2E - 04	2.9E - 02	1.1E - 02
Zinc	1.5E - 04	1.0E - 02	<u>1.5E - 02</u>
Total Pathway Hazard			4.4E - 02
<u>Pathway: Ingestion</u>			
Cadmium	1.2E - 05	5.0E - 04	6.2E - 09
Chromium	1.2E - 04	5.0E - 03	6.2E - 07
Fluoranthene	2.3E - 06	4.0E - 02	9.1E - 08
Pyrene	2.0E - 05	3.0E - 02	6.0E - 07
Zinc	3.8E - 03	2.0E - 01	<u>7.7E - 04</u>
Total Pathway Hazard			8.0E - 04
Total Site Hazard			4.5E - 02

<sup>a</sup>CDI = chronic daily intake.

<sup>b</sup>RfD = reference dose.

*Table 5-33. Surface Soil Risk Characterization: Noncarcinogenic Effects  
Average Exposure  
Future On-Site Residential  
Sites/SWMUs 12,14,15,29,30 (Industrial Area)*

Chemical	CDI <sup>(a)</sup> (mg/kg/day)	Adjusted RfD <sup>(b)</sup> (mg/kg/day)	Hazard Quotient
<u>Pathway: Dermal Exposure</u>			
Cadmium	4.1E - 08	4.0E - 05	1.0E - 03
Chromium	5.4E - 07	1.0E - 03	5.4E - 04
Fluoranthene	6.7E - 06	3.8E - 02	1.8E - 04
Pyrene	3.9E - 05	2.9E - 02	1.3E - 03
Zinc	1.5E - 05	1.0E - 02	<u>1.5E - 03</u>
Total Pathway Hazard			4.5E - 03
<u>Pathway: Ingestion</u>			
Cadmium	1.2E - 06	5.0E - 04	2.4E - 03
Chromium	1.6E - 05	5.0E - 03	3.2E - 03
Fluoranthene	4.9E - 07	4.0E - 02	1.2E - 05
Pyrene	2.8E - 06	3.0E - 02	9.3E - 05
Zinc	4.5E - 04	2.0E - 01	<u>2.2E - 03</u>
Total Pathway Hazard			8.0E - 03
Total Site Hazard			1.3E - 02

<sup>a</sup>CDI = chronic daily intake.

<sup>b</sup>RfD = reference dose.

*Table 5-34. Groundwater Risk Characterization: Noncarcinogenic Effects  
Reasonable Maximum Exposure  
Future On-Site Residential  
Sites/SWMUs 12,14,15,29,30 (Industrial Area)*

Chemical	CDI <sup>(a)</sup> (mg/kg/day)	RfD <sup>(b)</sup> (mg/kg/day)	Hazard Quotient
Arsenic	7.5 E-04	3.0 E-04	2.5 E+00
Barium	4.1 E-03	7.0 E-02	5.9 E-02
Beryllium	5.4 E-05	5.0 E-03	1.1 E-02
Chromium	2.4 E-02	5.0 E-03	4.9 E+00
Fluoride	3.5 E-05	6.0 E-02	5.8 E-04
Magnesium	3.0 E-03	1.0 E-01	3.0 E-02
Nickel	1.0 E-02	2.0 E-02	5.0 E-01
Thallium	1.7 E-04	7.5 E-05	2.3 E+00
Zinc	6.4 E-02	2.0 E-01	3.2 E-01
Bis(2-ethylhexyl)phthlate	2.7 E-02	2.0 E-02	1.3 E+00
Carbon tetrachloride	1.4 E-03	7.0 E-04	2.0 E+00
Chloroform	1.7 E-04	1.0 E-02	1.7 E-02
Cyclonite	2.9 E-04	3.0 E-03	9.6 E-02
1,1-dichloroethene	8.8 E-05	9.0 E-03	9.8 E-03
1,2-dichloroethylene	1.7 E-04	1.0 E-02	1.7 E-02
Toluene	2.9 E-04	2.0 E-01	8.5 E-04
1,1,1-trichloroethane	1.6 E-03	9.0 E-02	<u>1.8 E-02</u>
Total Pathway Hazard Index			1.4 E+01

<sup>a</sup>CDI = chronic daily intake.

<sup>b</sup>RfD = reference dose.

*Table 5-35. Groundwater Risk Characterization: Noncarcinogenic Effects  
Average Exposure  
Future On-Site Residential  
Sites/SWMUs 12,14,15,29,30 (Industrial Area)*

Chemical	CDI <sup>(a)</sup> (mg/kg/day)	RfD <sup>(b)</sup> (mg/kg/day)	Hazard Quotient
Arsenic	2.8 E-05	3.0 E-04	9.3 E-02
Barium	5.0 E-04	7.0 E-02	7.2 E-03
Beryllium	8.2 E-07	5.0 E-03	1.6 E-04
Chromium	2.8 E-04	5.0 E-03	5.5 E-02
Fluoride	2.5 E-05	6.0 E-02	4.2 E-04
Magnesium	2.1 E-03	1.0 E-01	2.1 E-02
Nickel	8.3 E-03	2.0 E-02	4.2 E-01
Thallium	2.1 E-05	7.5 E-05	2.7 E-01
Zinc	3.0 E-03	2.0 E-01	1.5 E-02
Bis(2-ethylhexyl)phthlate	3.5 E-04	2.0 E-02	1.8 E-02
Carbon tetrachloride	2.5 E-05	7.0 E-04	3.6 E-02
Chloroform	1.2 E-05	1.0 E-02	1.2 E-03
Cyclonite	2.4 E-04	3.0 E-03	8.0 E-02
1,1-dichloroethene	1.1 E-05	9.0 E-03	1.2 E-03
1,2-dichloroethylene	1.2 E-05	1.0 E-02	1.2 E-03
Toluene	1.0 E-05	2.0 E-01	5.1 E-05
1,1,1-trichloroethane	1.0 E-05	9.0 E-02	<u>1.1 E-04</u>
Total Pathway Hazard Index			1.0 E+00

<sup>a</sup>CDI = chronic daily intake.

<sup>b</sup>RfD = reference dose.

*Table 5-36. Surface Soil Risk Characterization: Noncarcinogenic Effects  
Future On-Site Residential Site/SWMU 1*

Chemical	CDI <sup>(a)</sup> (mg/kg/day)	Adjusted RfD <sup>(b)</sup> (mg/kg/day)	Hazard Quotient
<u>Pathway: Dermal Exposure</u>			
Barium	1.5E - 05	3.5E - 03	4.3E - 03
Cadmium	3.4E - 07	4.0E - 05	8.5E - 03
2,4,6-Trinitrotoluene	1.0E - 02	4.8E - 04	<u>2.1E + 01</u>
Total Pathway Hazard			2.1E + 01
<u>Pathway: Ingestion</u>			
Barium	1.2E - 04	7.0E - 02	1.7E - 03
Cadmium	2.5E - 06	5.0E - 04	5.0E - 03
2,4,6-Trinitrotoluene	2.0E - 04	5.0E - 04	<u>3.8E - 01</u>
Total Pathway Hazard			3.9E - 01
Total Pathway Hazard Index Soil:			2.1E + 01

<sup>a</sup>CDI = chronic daily intake.

<sup>b</sup>RfD = reference dose.

*Table 5-37. Groundwater Risk Characterization: Noncarcinogenic Effects  
Reasonable Maximum Exposure  
Future On-Site Residential Site/SWMU 2*

Chemical	CDI <sup>(a)</sup> (mg/kg/day)	RfD <sup>(b)</sup> (mg/kg/day)	Hazard Quotient
Arsenic	1.1 E-04	3.0 E-04	3.5 E-01
Carbon tetrachloride	1.4 E-03	7.0 E-04	2.1 E+00
Chloroform	4.9 E-05	1.0 E-02	4.9 E-03
Chromium	1.4 E-03	5.0 E-03	2.8 E-01
Cadmium	4.2 E-04	5.0 E-03	8.4 E-02
1,2-Dichlorobenzene	2.8 E-05	9.0 E-02	3.1 E-04
1,1-Dichloroethane	5.3 E-03	1.0 E-01	5.3 E-02
1,1-Dichloroethene	1.0 E-04	9.0 E-03	1.1 E-02
Ethylbenzene	2.1 E-05	1.0 E-01	2.1 E-04
Manganese	1.9 E-01	1.0 E-01	1.9 E+00
Tetrachloroethylene	1.1 E-05	1.0 E-02	1.1 E-03
Toluene	4.2 E-05	2.0 E-01	2.1 E-04
1,1,1-Trichloroethane	7.0 E-03	9.0 E-02	7.8 E-02
m-Xylene	1.3 E-04	2.0 E+00	6.7 E-05
o-Xylene	3.5 E-05	2.0 E+00	1.8 E-05
Zinc	3.1 E-02	2.0 E-01	<u>1.5 E-01</u>
Total Pathway Hazard Index			4.9 E+00

<sup>a</sup>CDI = chronic daily intake.

<sup>b</sup>RfD = reference dose.



*Table 5-38. Groundwater Risk Characterization: Noncarcinogenic Effects  
Reasonable Maximum Exposure  
Future On-Site Residential Site/SWMU 2*

Chemical	CDI <sup>(a)</sup> (mg/kg/day)	RfD <sup>(b)</sup> (mg/kg/day)	Hazard Quotient
Arsenic	1.9 E-05	3.0 E-04	6.3 E-02
Carbon tetrachloride	5.7 E-05	7.0 E-04	8.2 E-02
Chromium	9.9 E-05	5.0 E-03	2.0 E-02
Cadmium	4.2 E-04	5.0 E-03	8.4 E-02
1,2-Dichlorobenzene	4.6 E-06	9.0 E-02	5.1 E-05
1,1-Dichloroethane	4.3 E-04	1.0 E-01	4.3 E-03
1,1-Dichloroethene	8.6 E-06	9.0 E-03	9.6 E-04
Ethylbenzene	1.7 E-06	1.0 E-01	1.7 E-05
Manganese	1.0 E-02	1.0 E-01	1.0 E-01
Tetrachloroethylene	1.1 E-06	1.0 E-02	1.1 E-04
Toluene	3.4 E-06	2.0 E-01	1.7 E-05
1,1,1-Trichloroethane	5.9 E-04	9.0 E-02	6.6 E-03
m-Xylene	1.1 E-05	2.0 E+00	5.5 E-06
o-Xylene	2.9 E-06	2.0 E+00	1.4 E-06
Zinc	2.0 E-03	2.0 E-01	<u>9.8 E-03</u>
Total Pathway Hazard Index			3.7 E-01

<sup>a</sup>CDI = chronic daily intake.

<sup>b</sup>RfD = reference dose.

*Table 5-39. Surface Soil Risk Characterization: Noncarcinogenic Effects  
Future On-Site Residential Site/SWMU 3*

Chemical	CDI <sup>(a)</sup> (mg/kg/day)	Adjusted RfD <sup>(b)</sup> (mg/kg/day)	Hazard Quotient
<u>Pathway: Dermal Exposure</u>			
Chromium	6.7E-06	1.0E - 03	<u>6.7E - 03</u>
Total Pathway Hazard			6.7E - 03
<u>Pathway: Ingestion</u>			
Chromium	1.1E - 04	5.0E - 03	<u>2.2E - 02</u>
Total Pathway Hazard			2.2E - 02
Total Pathway Hazard Index			2.9E - 02

<sup>a</sup>CDI = chronic daily intake.

<sup>b</sup>RfD = reference dose.

*Table 5-40. Surface Soil Risk Characterization: Noncarcinogenic Effects  
Future On-Site Residential Site/SWMU 7*

Chemical	CDI <sup>(a)</sup> (mg/kg/day)	Adjusted RfD <sup>(b)</sup> (mg/kg/day)	Hazard Quotient
<u>Pathway: Dermal Exposure</u>			
Beryllium	1.1E - 07	2.5E - 04	4.4E - 04
Cadmium	6.7E - 07	4.0E - 05	1.7E - 02
Nickel	5.6E - 06	1.0E - 03	5.6E - 03
Zinc	4.4E - 04	1.0E - 02	4.4E - 02
Fluoride	1.4E - 06	3.0E - 03	4.7E - 04
Total Pathway Hazard			6.8E - 02
<u>Pathway: Ingestion</u>			
Beryllium	1.9E - 06	5.0E - 03	3.7E - 04
Cadmium	1.2E - 05	5.0E - 04	2.4E - 02
Nickel	9.8E - 05	2.0E - 02	5.2E - 03
Zinc	7.3E - 03	2.0E - 01	3.9E - 02
Fluoride	2.4E - 05	6.0E - 02	4.2E - 04
Total Pathway Hazard			6.9E - 02
Total Pathway Hazard Index			1.4E - 01

<sup>a</sup>CDI = chronic daily intake.

<sup>b</sup>RfD = reference dose.

*Table 5-41. Surface Soil Risk Characterization: Noncarcinogenic Effects  
Future On-Site Residential Sites/SWMUs 10/11*

Chemical	CDI <sup>(a)</sup> (mg/kg/day)	Adjusted RfD <sup>(b)</sup> (mg/kg/day)	Hazard Quotient
<u>Pathway: Dermal Exposure</u>			
Barium	9.0E - 06	3.5E - 03	2.6E - 03
Silver	4.4E - 09	2.5E - 04	1.8E - 05
Zinc	3.5E - 06	1.0E - 02	3.5E - 04
Nitrate/Nitrite	1.3E - 05	5.0E - 03	2.6E - 03
1,3,5-trinitrobenzene	4.0E - 03	4.8E - 05	8.3E + 01
2,4,6-trinitrotoluene	1.8E - 00	4.8E - 04	<u>3.8E + 03</u>
Total Pathway Hazard			3.9E + 03
<u>Pathway: Ingestion</u>			
Barium	1.5E - 04	7.0E - 02	2.1E - 03
Silver	7.3E - 08	3.0E - 03	2.4E - 05
Zinc	5.9E - 05	2.0E - 01	3.0E - 04
Nitrate/Nitrite	2.2E - 04	1.0E - 01	2.2E - 03
1,3,5-trinitrobenzene	1.7E - 04	5.0E - 05	3.4E + 00
2,4,6-trinitrotoluene	7.6E - 02	5.0E - 04	<u>1.5E + 02</u>
Total Pathway Hazard			1.5E + 02
Total Pathway Hazard Index			4.0E + 03

<sup>a</sup>CDI = chronic daily intake.

<sup>b</sup>RfD = reference dose.

Table 5-42. Groundwater Risk Characterization: Noncarcinogenic Effects  
Future On-Site Residential Sites/SWMUs 10/11

Chemical	CDI <sup>(a)</sup> (mg/kg/day)	RfD (mg/kg/day)	Hazard Quotient
<u>Pathway: Ingestion</u>			
Arsenic	3.82 E-03	3.0 E-04	1.3 E+01
Barium	3.26 E-03	7.0 E-02	4.7 E-02
Chromium	5.21 E-04	5.0 E-03	1.0 E-01
Copper	1.15 E-03	3.7 E-02	3.1 E-02
Fluoride	2.3 E-01	6.0 E-02	3.8 E+0
Nickel	1.15 E-03	2.0 E-02	5.7 E-02
Silver	2.08 E-05	3.0 E-03	6.9 E-03
Thallium	1.18 E-04	7.0 E-05	1.7 E+0
Zinc	3.12 E-03	2.0 E-01	1.6 E-02
Benzyl Alcohol	2.78 E-04	3.0 E-01	9.3E-04
Bis(2-ethylhexyl)phthlate	3.47 E-04	2.0 E-02	1.7 E-02
Chloroform	6.94 E-05	1.0 E-02	6.9 E-03
Phenol	1.04 E-04	6.0 E-01	1.7 E-04
Toluene	2.08 E-04	2.0 E-01	1.0 E-03
2,4,6-Trinitrotoluene	1.30 E-03	5.0 E-04	2.6 E+0
Total Pathway Hazard Index			2.1 E+01

<sup>a</sup>CDI = chronic daily intake.

### 5.3 RISK CHARACTERIZATION SUMMARY

On-site and off-site risks for current and future land-use conditions are summarized in Tables 5-43 through 5-45. The exposure pathways considered are for surface soil, groundwater, and air. Permanent surface water and associated stream sediments are not present on TEAD-N because of meteorological conditions and physical site characteristics. Note that RME values for total pathway risk and hazard are given for all cases in Tables 5-43 through 5-45. (Where data were available, average risk and hazard were calculated and summed where appropriate.)

#### 5.3.1 Current Land Use

Carcinogenic risk for industrial exposure to surface soils and volatilized chemicals on the industrial eastern portion of the site is estimated to be  $3.9 \text{ E}^{-04}$ , although no noncarcinogenic health hazard is indicated. This portion of the base comprises the sanitary landfill, sewage lagoons, and drum storage areas. The estimated risk level is higher than the generally accepted carcinogenic risk level of  $1 \text{ E}^{-06}$ . Other on-site worker exposure scenarios for which data were available (Site/SWMU 1) showed potential for carcinogenic risk and for noncarcinogenic health hazards. The estimated risk level for on-site residents was  $1.3 \text{ E}^{-06}$ , with no noncarcinogenic health hazard indicated.

Under current conditions, there are no complete pathways for on-site exposure to groundwater. The lack of airborne particulate concentration data precluded assessment of the particulate inhalation pathway.

Four of five off-site exposure scenarios showed a potential risk (Table 5-44). Carcinogenic risk for residents ingesting groundwater from Well 12, which is approximately 22,000 feet to the north of the industrial area, was  $1.1 \text{ E}^{-06}$ . Groundwater in this area is potentially influenced by the industrial eastern portion of the site. Carcinogenic risk with no adverse health hazard was indicated for residents of Grantsville, the city of Tooele, and Stockton.

#### 5.3.2 Future Land Use

The most significant potential carcinogenic risk to hypothetical future on-site residents is  $2.8 \text{ E}^{-03}$ , related to soil exposure and groundwater ingestion at the TNT Washout Facility (Sites/SWMUs 10/11). This value is above the EPA remedial goals of  $1 \text{ E}^{-04}$  to  $1 \text{ E}^{-06}$  risk. The potential for adverse noncarcinogenic health effects also is indicated by a Hazard Index of  $4.0 \text{ E}^{+03}$  (see Table 5-45). A potential significant incremental cancer risk is indicated by risk estimates of  $1.2 \text{ E}^{-04}$  and  $7.5 \text{ E}^{-06}$  for hypothetical future residents exposed to surface soils on the OB/OD Areas and the Chemical Range (Sites/SWMUs 1 and 7, respectively). The Hazard Index also exceeds unity at the OB/OD Areas. The industrial eastern portion of the site shows carcinogenic risks of  $7.4 \text{ E}^{-03}$  and health hazards of  $1.4 \text{ E}^{+01}$  to a future hypothetical resident for RME levels. However, note that available average-carcinogenic-risks values for the industrial area are within EPA remediation goals, and the hazard index

Table 5-43. Summary of Current On-Site Risks

Exposure Pathway	Industrial Worker			On-Site Worker <sup>(a)</sup> Site 1			On-Site Worker <sup>(a)</sup> Site 3			On-Site Worker <sup>(a)</sup> Site 7			On-Site Worker <sup>(a)</sup> Site 10/11			Resident On-Site Housing		
	Carcinogenic Risk	Hazard Index		Carcinogenic Risk	Hazard Index		Carcinogenic Risk	Hazard Index		Carcinogenic Risk	Hazard Index		Carcinogenic Risk	Hazard Index		Carcinogenic Risk	Hazard Index	
SURFACE SOIL																		
Dermal Exposure	RME <sup>(b)</sup> 3.9E-04 Avg 2.1E-04	1.9E-02 9.3E-03		1.2E-05	2.7E+00		---	---		---	---		---	---		---	---	
Ingestion	RME <sup>(b)</sup> 7.6E-06 Avg 4.5E-06	8.0E-03 3.8E-03		2.2E-07	5.2E-02		---	---		---	---		---	---		---	---	
GROUNDWATER																		
Ingestion <sup>(c)</sup>	---	---		---	---		---	---		---	---		---	---		---	---	
AIR																		
Inhalation	2.8E-08	1.6E-05		---	---		---	---		---	---		---	---		---	---	
Total Pathways	RME 3.9E-04	2.7E-02		1.2E-05	2.7E+00		---	---		---	---		---	---		1.3E-06	9.3E-06	

<sup>(a)</sup>These sites are inactive and therefore not considered under the current on-site exposure scenario.

<sup>(b)</sup>Reasonable Maximum Exposure Level.

<sup>(c)</sup>Pathways incomplete.

<sup>(d)</sup>Toxicity factors not available.

Table 5-44. Summary of Current Off-Site Risks

Exposure Pathway	Resident Well 12		Resident Wells 10 and 16		Resident Well OY		Resident Grantsville		Resident Tooele		Resident Stockton	
	Carcinogenic Risk	Hazard Index	Carcinogenic Risk	Hazard Index	Carcinogenic Risk	Hazard Index	Carcinogenic Risk	Hazard Index	Carcinogenic Risk	Hazard Index	Carcinogenic Risk	Hazard Index
SURFACE SOIL <sup>(a)</sup>	--	--	--	--	--	--	--	--	--	--	--	--
GROUNDWATER												
Ingestion	4.4 E-07	1.7 E-02	--- <sup>(b)</sup>	--- <sup>(b)</sup>	6.0 E-07	2.5 E-02	---	---	---	---	---	---
AIR												
Inhalation	---	---	---	---	---	---	---	---	---	---	---	---
Total Pathways	4.4 E-07	1.7 E-02	--	--	6.0 E-07	2.5 E-02	3.1 E-05	1.0 E-05	3.8 E-05	3.7 E-05	8.9 E-06	6.6 E-0
							3.1 E-05	1.0 E-05	3.8 E-05	3.7 E-05	8.9 E-06	6.6 E-0

<sup>a</sup>Airborne soil particulate concentrations were not available.

<sup>b</sup>No toxicity factors available.

<sup>c</sup>Exposures were insignificant or pathways were incomplete.

<sup>d</sup>Not addressed in screening level model.



Table 5-45. Summary of Future On-

Exposure Pathway	Industrial Worker		Residential Industrial Area		Residential Site 1		Residential Site 2	
	Carcinogenic Risk	Hazard Index	Carcinogenic Risk	Hazard Index	Carcinogenic Risk	Hazard Index	Carcinogenic Risk	Hazard Index
<b>SURFACE SOIL</b>								
Dermal Exposure	REM <sup>(a)</sup>	2.1 E-02	1.1 E-03	4.4 E-02	1.2 E-04	2.1 E+01	---	---
	AVG.	1.0 E-02	3.3 E-04	4.5 E-03	---	---	---	---
Ingestion	REM <sup>(a)</sup>	8.0 E-03	2.0 E-04	8.0 E-04	4.9 E-06	3.9 E-01	---	---
	AVG.	3.8 E-03	1.2 E-05	8.0 E-03	---	---	---	---
<b>GROUNDWATER</b>								
Ingestion	REM <sup>(a)</sup>	---	6.1 E-03	1.4 E+01	---	---	8.8 E-05	4.9 E+00
	AVG.	---	2.2 E-04	1.0 E+00	---	---	8.0 E-06	3.7 E-01
<b>AIR</b>								
Inhalation	2.8 E-08	1.6 E-05	5.7 E-10	---	---	---	---	---
Total Pathways	3.9 E-04	2.7 E-02	7.4 E-03	1.4 E+01 (1.0 E+00) <sup>(b)</sup>	1.2 E-04	2.1 E+01	8.8 E-05 (8.0 E-06) <sup>(b)</sup>	4.9 E+00 (3.7 E-01)

<sup>(a)</sup>No slope factors were available.

<sup>(b)</sup>Reasonable Maximum Exposure Level.

<sup>(c)</sup>Pathway incomplete.

<sup>(d)</sup>Toxicity factors not available.

<sup>(e)</sup>No volatiles were present in soils.

<sup>(f)</sup>Total Pathway Average Exposure Level.

does not exceed unity, indicating no concern for non-carcinogenic health effects. The hazard index for a resident consuming groundwater at the IWL is above unity ( $4.9 \times 10^0$ ) for RME levels. However, for average exposure levels the hazard index is well below unity.

### 5.3.3 Site-Wide Risk

The carcinogenic risk and health hazards for off-site receptors for the groundwater and air pathways would represent practicable site-wide risk to these receptors. As shown in Table 5-45, the total pathway carcinogenic risk to residents of Grantsville, Stockton, and the city of Tooele are above the EPA remedial goal. The on-site industrial-worker scenarios also would represent area-wide risk for the eastern portion of TEAD-N. The total pathway carcinogenic risk for industrial workers is above EPA remedial goals (see Tables 5-43 and 5-45). The present definition of extent of contamination and the areal separation between waste sites preclude complete characterization of base-wide risk for TEAD-N.

## 5.4 UNCERTAINTY ANALYSIS

One of the largest sources of uncertainty in the risk characterization is the lack of verified toxicological data for the chemicals of potential concern. Sixteen of the chemicals of potential concern classified by USEPA as carcinogens lack either oral- or inhalation-slope factors or both. Without slope factors, these chemicals cannot be included in the quantification of potential risk. Chromium, one of the four chemicals of potential concern classified as an A (known) carcinogen, was found at elevated levels in soil at the industrial area. It does not have an oral-slope factor and, therefore, cannot be included in the estimation of risk to on-site workers. Lack of inhalation toxicity factors for the volatiles found in surface soils at Sites/SWMUs 1 and 10/11 prevented quantitative evaluation of potential risk or hazard from inhalation of those volatiles at those sites. Nitrate was found in very high concentrations in groundwater at Sites/SWMUs 10/11 ( $.2642 \mu\text{g/l}$ ) and in moderate concentrations at 1 ( $.0175 \mu\text{g/l}$ ), but it does not have oral-toxicity factors and cannot be included in the quantitative-risk characterization.

On the other hand, the chemical that contributed most to the estimate of cancer risk at Sites/SWMUs 10/11 through the soil ingestion and dermal absorption pathways is 2,4,6-trinitrotoluene. This chemical, however, with a weight-of-evidence classification of C, has shown no evidence of carcinogenicity in humans and only limited evidence in animals. In addition, 2,4,6-trinitrotoluene also contributed significantly to risk through groundwater ingestion at Sites/SWMUs 10/11. RDX, another chemical classified C, was responsible for over half (54 percent) of the risk at Sites/SWMUs 10/11 from groundwater ingestion.

In order to account for the fact that the intake from dermal absorption represents an absorbed rather than an administered dose, adjustments were made to the toxicity factors that were used to estimate risk and hazard. These adjustments were based on an estimate of gastrointestinal-absorption efficiency (applied to the oral-slope factor of RfD). Due to lack of available data on oral absorption efficiency for some of these chemicals, a conservative assumption of gastrointestinal absorption efficiency of 5 percent was assumed for metals and

inorganics and 95 percent for organics. Use of a default factor introduces uncertainty into the characterization of risk from soil-dermal absorption.

Uncertainty can result from assessing the toxicity of a mixture of chemicals. For each exposure pathway, chemicals present at a site were assumed to act additively, and risk was evaluated by summing cancer risks and calculating hazard indices. This may overestimate or underestimate risk depending upon the extent to which this assumption is correct.

Uncertainty can also result from combining all pathways for a site, which assumes that one individual would be exposed to all of those pathways.

Two pathways for groundwater-exposure dermal absorption and inhalation during showering were not evaluated due to lack of sufficient data to adequately model these potential exposures.

## **6.0 UNCERTAINTY ANALYSIS**

Uncertainty can arise in each phase of the risk-evaluation process. The net effect can be either an underestimation or overestimation of potential risk to receptors. This PBRA is based on existing data. Many sites are incompletely characterized, and no sampling has been completed at others. The results of the fate and transport models are based on either the single or maximum concentration reported for a given chemical. A range in concentrations could not be defined for this screening-level risk evaluation.

### **6.1 DATA EVALUATION**

Uncertainty in site characterization exists because of the limited sample data and the variability of sample types. At a number of sites, the sample concentrations were not necessarily characteristic of affected media. The limited number of samples collected at some sites and lack of replication prevent development of means and evaluation of standard error. The lack of adequate background data for some chemicals may result in improper elimination or inclusion for risk analysis.

Uncertainty in the representativeness of groundwater data results from the fact that several sites are in close proximity and monitoring data from a single well may inappropriately characterize a site for fate and transport modeling. Groundwater analytes were inconsistent among sites.

### **6.2 CHEMICALS OF POTENTIAL CONCERN**

Limited site data and inadequate background data can affect the selection of appropriate chemicals of potential concern, thereby creating uncertainty in the risk characterization.

### **6.3 EXPOSURE ASSUMPTIONS**

The incomplete characterization of affected media and definition of extent of contamination at some waste sites increase uncertainty in pathway analysis and subsequent intake calculations. Data limitations, such as no reliable ambient particulate concentrations and no site-specific meteorological data, prevent development of some complex exposure pathways and allow only screening-level analysis of fate and transport.

Uncertainty is inherent in the applicability of selected fate and transport models for given exposure scenarios in emission-rate deviation and transport assumptions for volatile organics. Several parameter values must be estimated for intake equations. A number of the exposure parameters are standard default values supplied by the EPA, rather than site-specific values.

A residential future land-use scenario was developed for the eastern portion of the site even though industrial use is expected to continue for the foreseeable future. Therefore, risk

estimates derived for the residential scenario may overestimate risk posed by the eastern portion of the site.

#### **6.4 TOXICITY ASSESSMENT**

Lack of toxicity values for some chemicals prevent their inclusion in the overall risk characterization and may result in underestimation of risk or health hazard. The weight-of-evidence classification of carcinogens affects the significance of estimated risks.

Assumptions employed in converting inhalation-unit risks and reference concentrations to doses contribute to uncertainty in the toxicity assessment. A number of the dermal toxicity values developed in the toxicity assessment are based on assumptions of gastrointestinal-absorption efficiency.

#### **6.5 RISK CHARACTERIZATION**

Sixteen of the chemicals of potential concern lacked either oral- or inhalation-slope factors or both, thereby precluding their inclusion in the carcinogenic risk characterization.

Uncertainty can result from assessing the risk from chemical mixtures. Chemicals present at the sites were assumed to act additively, and risks were derived by summation of chemical-specific risks. This may overestimate or underestimate risk. Further uncertainty arises in the combination of risks from several pathways to represent risk for a single receptor.

## **7.0 DATA NEEDS**

This PBRA is based on data available at present. The RI has not been completed to date. Data needs for the BRA will be developed on the basis of the Final Work Plan for RI/FS (USATHAMA, 1992).

### **7.1 GENERAL DATA REQUIREMENTS**

A sufficient number of samples (minimum of three) are required to calculate mean and upper 95-percent-confidence limits and to define extent of contamination for chemicals of concern in all affected media at each waste site.

Existing background data for groundwater are inadequate in terms of the analytes, and quality is suspect. Sufficient background samples should be collected to permit statistical comparisons between background levels and concentrations in affected media

#### **7.1.1 Soil**

Surface-soil samples are required to properly evaluate soil-exposure pathways.

#### **7.1.2 Groundwater**

Aquifer characteristics are insufficiently described across TEAD-N. Specifically, additional characterization should include site-wide determinations of the hydraulic gradient (both vertical and horizontal), porosity, hydraulic conductivity, fraction organic carbon, and aquifer thickness. The extent of groundwater contamination relative to each waste site should be defined.

#### **7.1.3 Air**

The following minimum information is required for a detailed air-impact study:

- On-site meteorological data. A minimum of 1-year data will be required.
- Detailed surface-soil data for all Sites/SWMUs with surficial contamination. This includes Sites/SWMUs for which current soil data are inadequate to rule out subsequent air contamination by volatilization and/or wind erosion.
- Soil-gas samples for all contaminated areas. The soil-gas results will be used to verify the accuracy of the emission-rate estimates predicted by CHEMDAT7.

- Ambient particulate data at contaminated sites. Results of the particulate monitoring will be used to estimate emissions of particulates and non-volatile toxic-air pollutants. Particulate data must be collected according to EPA criteria and should include PM<sub>10</sub> and Total Suspended Particulate (TSP) only at sites with known surficial contamination.
- The oil content of the soil. The total organic carbon content of the soil was used for this report and may tend to overestimate emission rates of the VOCs.

## 8.0 REFERENCES

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**APPENDIX A**

**FATE AND TRANSPORT OF VOLATILE ORGANIC COMPOUND**

**AIR EMISSIONS**



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## **Appendix A**

### **Acronyms/Abbreviations**

ISCST	Industrial Source Complex Short Term
km	kilometer
TEAD-N	Tooele Army Depot-North Area
TOC	total organic compound
TSDF	treatment, storage, and disposal facility
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compound



## **1.0 INTRODUCTION**

### **1.1 MOTIVATION FOR FATE AND TRANSPORT MODELING**

A health risk assessment is being performed for the North Area of the Tooele Army Depot (TEAD-N). The health risk assessment focuses on (1) long-term health effects caused by living near the TEAD-N facility (off-site residential), (2) long-term health effects caused by living at the TEAD-N facility (future on-site residential), (3) long-term health effects caused by worker exposure within the industrial area of the TEAD-N facility (on-site worker), and (4) long-term health effects caused by living at the existing full-family and WHERRY housing at the TEAD-N facility (current on-site residential). For scenarios (1) and (2), it is assumed that a person living at the impacted area will be exposed for 30 years over a lifetime. For scenarios (3) and (4), it is assumed that a person working or currently living on-site will be exposed for 10 years over a lifetime. The average length of residence for the current on-site residential scenario does not exceed 2 years.

To address health risks associated with the inhalation pathway, air quality impacts related to volatile-organic-compound (VOC) emissions from TEAD-N were needed. Fate and transport modeling was used to estimate these impacts.

### **1.2 PROJECT OVERVIEW**

The TEAD-N facility has been used, in part, for storage, treatment, and testing of conventional weapons and chemicals. Past activities at TEAD-N have resulted in the disposal or release of hazardous compounds to the environment (i.e., the ground, run-off water, and the atmosphere).

A remedial investigation has been performed for TEAD-N to determine potential risks to the local population and the environment associated with these activities. During the investigation, a number of contaminated ground-surface sites (hereinafter referred to as Sites/SWMUs) at the facility were identified as potential sources of continued groundwater contamination and air emissions of toxic pollutants. At each Site/SWMU, toxic compounds identified for further review included organic compounds and/or heavy metals.

Air emissions of toxic compounds from the Sites/SWMUs can occur by either direct volatilization of the toxic compounds or by entrainment of contaminated dust from wind erosion. With entrainment, it is assumed that small amounts of the organic compounds or heavy metals comprise or are adsorbed into the surface of dust particles. At ambient temperatures, the heavy metals can only become airborne by entrainment. However, the organic compounds can become airborne through either entrainment or volatilization.

This appendix summarizes fate and transport through the atmosphere by volatilization only. As such, only the VOCs are considered. Insufficient data exist to evaluate solid-phase contaminants

in the atmosphere. Fate and transport were assessed using an air-emissions model and an air-dispersion model. These models are discussed in Sections 2.0 and 3.0 of this report.

In addition, air emissions of VOCs from two proposed air strippers at the TEAD-N facility will be considered in the analysis. The air strippers will be used for groundwater remediation.

### **1.3 EXISTING ENVIRONMENT**

The TEAD-N facility is located in the Tooele Valley of northern Utah. It covers approximately 100 square kilometers (km) and is surrounded by three small towns located just beyond the facility boundaries: Grantsville (0.8 km to the north), Tooele (adjacent to TEAD-N to the east), and Stockton (3.4 km to the south). These towns are also within the Tooele Valley.

The terrain within TEAD-N boundaries is generally uniform with a moderate slope toward the north. The facility is surrounded by rugged terrain to the south, west, and east. The three surrounding towns lie at the base of the rugged terrain.

The climate is arid. Potential evapotranspiration exceeds precipitation for most months. As such, there is little or no standing water most of the year.

### **1.4 SITE/SWMU DESCRIPTIONS**

The Sites/SWMUs are distributed mainly over the southern and eastern portions of the TEAD-N facility with the industrial Sites/SWMUs concentrated in the eastern portion. A list of Sites/SWMUs identified in the remedial investigation for further review is given in Table A-1, along with a brief description and areal coverage of contamination. Not all Sites/SWMUs were identified as having potential air emissions of VOCs. Contaminant concentrations and air-emission rates are discussed in Section 2.0.

Sites/SWMUs 2, 4, 12, 14, 15, 17, 29, 30, 32, and 42 are considered to be in the industrial area of the facility. Site/SWMU 2 is capped and will not be included in the air fate and transport analysis. For the purpose of the health risk assessment, it is assumed that these Sites/SWMUs will remain industrial. All other Sites/SWMUs are considered to be possible, future, residential sites.

### **1.5 AIR-STRIPPER DESCRIPTION**

The two air strippers will be housed within a single, 20-foot-tall building located approximately 1.7 kilometers to the northeast of Site/SWMU 2. The air strippers will operate continuously and will have a design life of 30 years. Each unit will treat contaminated groundwater and will omit 3.19 pounds of trichloroethylene per hour into the atmosphere. The stack characteristics of each



*Table A-1. Site/SWMU Descriptions*

Site/ SWMU #	Description	Areal Coverage (ft <sup>2</sup> )	Potential VOC Air Emissions <sup>a</sup>
1	Open burning/open detonation areas	736,500	yes
2	Former industrial wastewater lagoon	880,192	no
3	X-ray lagoon	2,500	no
4	Sandblast facility	90,000	no
5	Pole transformer PCB spill	3,750	no
6	Old burn area	2,226,000	no
7	Chemical range	9,850	no
10, 11	TNT washout area	1,053,959	yes
12, 15	Sanitary landfill	13,924,578	no
14	Sewage lagoons	840,000	no
17	Former transformer storage area	210,000	no
20	Furnace, parking lot, and underground tank	43,750	no
21	Deactivation furnace area (building 1320)	6,250	no
25	Battery shop	44,750	no
29	Drum storage area	944,063	yes
30	Old wastewater lagoon	481,200	yes
32	PCB spill site	22,500	no
36	Old burn staging area	101,200	no
38	Industrial wastewater treatment plant	625	no
41	Box elder wash drum site	90,000	no
42	Deactivation furnace area (building 539)	50,700	no

<sup>a</sup>Potential emissions due to volatilization at ambient temperature.

unit are as follows: stack height of 50 feet, stack diameter of 12 feet, and ambient exit temperature. The flow rate is unknown at this time. Therefore, these units will be conservatively modeled as area sources with ground-level releases. This will yield higher (i.e., more conservative) ground-level impacts than modeling the units with an elevated plume.

## **2.0 EMISSION RATE ESTIMATES**

### **2.1 CHEMDAT7 MODEL**

Emission rates for VOCs were estimated using U.S. Environmental Protection Agency's (USEPA) CHEMDAT7 air emission models described in USEPA's *Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF) - Air Emission Models* (EPA-450/3-87-026, November 1989). This model was identified as the most appropriate model available through discussions with the USEPA for estimating emissions of VOCs from contaminated soil (*personal discussion with Mr. Clark Allen-Research Triangle Institute (developer of the CHEMDAT7 model)*, February 24, 1992)

CHEMDAT7 is a Lotus 1-2-3™ spreadsheet that includes analytical models for estimating VOC emissions from treatment, storage, and disposal facility (TSDF) processes based on user-specified input parameters. The available models include disposal impoundments, closed landfills, land-treatment facilities, and aeration and nonaeration impoundment processes. The land-treatment model is the most applicable to the situation at the TEAD-N facility.

CHEMDAT7 calculates fractions of waste constituents that are distributed among pathways (partition fractions) applicable to the facility being modeled. A pathway is defined as any process, physical or chemical, that removes VOCs from the site. CHEMDAT7 considers the following pathways: adsorption, migration, runoff, biological decomposition, photochemical decomposition, hydrolysis, oxidation/reduction, hydroxyl radical reactions, and volatilization. The principal pathway of the VOCs modeled in this study is volatilization.

### **2.2 SOURCE DATA**

Contaminants and concentrations present in the soil and groundwater were listed for each Site/SWMU on Worksheet 1 (not shown) from USEPA's *Superfund Public Health Evaluation Manual* (EPA 540/1-86-060). For Sites/SWMUs with 20 or more contaminants listed on Worksheet 1, USEPA guidance allowed selection of a reduced number of contaminants for review using Worksheet 5 (not shown).

The VOCs listed on Worksheet 1 and 5 are presented in Table A-2. Only Sites/SWMUs with identified surficial contamination VOCs are shown in Table A-2 and were modeled. Polychlorobiphenyl (PCB) congeners were not considered volatile due to their low-vapor pressures.

### 2.3 MODEL INPUTS AND ASSUMPTIONS

Emission rates of VOCs to the atmosphere were estimated with CHEMDAT7 for the contaminants listed in Table A-2.

The physical and chemical properties for most contaminants were contained in CHEMDAT7's internal database. For compounds not contained in the database, it was necessary to obtain chemical/physical property information from external references. The following compounds were not included in the model database: tetryl, HMX, 1,3,5-trinitrobenzene, and 2,4,6-trinitrotoluene. The chemical and physical properties for these compounds were entered manually into the spreadsheet.

CHEMDAT7 assumes that the contaminants are applied to the soil in an oil matrix. The model requires input of an oil-loading term, expressed in grams of oil per cubic centimeter of soil (g oil/cm<sup>3</sup> soil). The contaminant concentration is then input as a fraction of the total oil. To represent the oil matrix for the TEAD-N Sites/SWMUs, model guidance (*personal discussion with Mr. Clark Allen-Research Triangle Institute (developer of the CHEMDAT7 model)*, February 24, 1992) suggested characterizing the oil as the sum of all organic contaminants and the naturally occurring low-volatile organic constituents of the soil. The naturally occurring low-volatile organics were represented by the total organic carbon (TOC) level in the soil. For Sites/SWMUs with little contamination, the oil loading was then essentially equal to the TOC.

Once the oil loading was calculated, the remaining parameters were input to the land-treatment model. The contaminant concentration was expressed as grams per cubic centimeter of oil (g contaminant/cm<sup>3</sup> oil). The contamination depth was assumed to be 5 feet. Total soil and air porosity was assumed to be 0.5 and 0, respectively. Molecular weight of the oil was assumed to be 300. This value was adjusted for the heavily contaminated Sites/SWMUs to account for the average molecular weight of the contaminant organics. Biodegradation was not considered a significant removal process. These assumptions were based on model guidance (*personal communication with Mr. Clark Allen-Research Triangle Institute (developer of the CHEMDAT7 model)*, February 24, 1992) and available site data.

Additional model inputs included an average temperature of 25 °C, an average wind speed of 10 miles per hour (determined from local meteorological data), and the area of each Site/SWMU.

The model was set to estimate average emission rates for 10-year (87,600-hour) and 30-year (262,800-hour) periods. These estimates were used as input to the air-dispersion-modeling analysis (see Section 3.0). An emission-rate determination was performed for each Site/SWMU listed in Table A-2 in order to estimate vapor-phase emission rates of the organic contaminants from the soil. The 10-year rates were used for assessing on-site impacts within the TEAD-N industrial area. The 30-year rates were used for assessing impacts within the off-site residential and future on-site residential areas.

*Table A-2. Organic Compounds and Soil Concentrations at Each Site/SWMU*

Site/SWMU	Contaminant	Soil Concentration (mg/kg soil)
1	2,4,6-trinitrotoluene (TNT)	52
	2,4-dinitrotoluene (DNT)	1.2
	2,6-DNT	1.1
	HMX	13
	tetryl	1.3
10,11	1,3,5-trinitrobenzene	47
	2,4-DNT	8.2
	2,4,6-TNT	20733
	HMX	95.2
29	benzo (a) anthracene	0.5
	benzo (a) pyrene	0.66
	benzo (b) fluoranthene	0.6
	chrysene	1.65
	fluoranthene	0.61
	phenanthrene	28
	pyrene	5.4
30	1,1,1-trichloroethane (TCA)	3.9
	carbon tetrachloride	1.4
	ethylbenzene	0.16
	tetrachloroethylene	3.6
	toluene	2.2
	trichloroethylene	0.016

## 2.4 CHEMDAT7 MODEL RESULTS

The emission estimates from CHEMDAT7 are given in Appendix A-1. ("Site" in Appendix A-1 refers to Site/SWMU.)

### **3.0 DISPERSION MODELING APPROACH**

Air-dispersion modeling was performed, following the air emission estimates, at a screening level to provide conservative estimates of air-quality impacts associated with transport of the VOCs from the sites/SWMUs and air strippers through the atmosphere.

Four air-quality-impact scenarios were investigated: (1) off-site residential, (2) future on-site residential, (3) on-site worker exposure, and (4) current on-site residential (see Section 1.1). Each required a separate air-quality-estimation approach.

Off-site residential impacts (Scenario 1) were estimated at the nearest town boundary for Grantsville, Tooele, and Stockton using a USEPA-approved air-dispersion model. For residential impacts, 30-year-average impacts were estimated based on the 30-year-average emission rates from the CHEMDAT7 modeling and emissions from the air strippers. Maximum potential impacts at a town boundary were identified by summing each Site/SWMU's and the air stripper contributions to the air quality at that location (i.e., cumulative impacts).

Future, on-site residential impacts (Scenario 2) were estimated, using a box-model approach, at Sites/SWMUs that have surficial VOC emissions. This involved applying a dilution factor to the Site/SWMU VOC emissions based on the wind speed. Sites/SWMUs 1, 10, 11, 29, and 30 were included in this scenario. It was assumed that each Site/SWMU was the most significant contributor to its own air quality. Contributions from other Sites/SWMUs were assumed to be significantly less due to dispersion of the air-borne contaminants over long distances. Therefore, no cumulative impacts were considered. For these residential impacts, 30-year-average impacts were estimated based on the 30-year-average-emission rates from the CHEMDAT7 modeling.

On-site worker impacts (Scenario 3) were estimated at Sites/SWMUs within the TEAD-N industrial area using a box model approach and at the vocational school using the same method as in Scenario 1. Only Sites/SWMUs with VOCs were considered. Due to the proximity of Sites/SWMUs in the industrial area, it was conservatively assumed that the Sites/SWMUs were co-located. Only SWMUs 29 and 30 were included for industrial-worker exposure. Maximum potential impacts within the industrial area were identified by summing the impacts from these two sites/SWMUs. For the vocational-school-worker exposure, maximum potential impacts were identified by summing the impacts (from dispersion modeling) from sites/SWMUs 1, 10, 11, 29, and 30, and the air strippers. For industrial- and vocational-school-worker exposure, 10-year-average impacts were estimated based on the 10-year-average emission rates from the CHEMDAT7 modeling.

Current on-site residential impacts (Scenario 4) were estimated at the full family and WHERRY housing area located in the southeastern corner of the TEAD-N facility. The method used to estimate these impacts was the same as that used for Scenario 1 except that 10-year-average emissions and impacts were considered.

Each approach for estimating air quality impacts is discussed in detail below.

### 3.1 SCENARIO 1: OFF-SITE RESIDENTIAL

Since the Sites/SWMUs are contaminated-ground-surface areas, each is considered to be an area source of air emissions with ground-level emission releases at ambient temperatures. As such, there is no plume rise due to momentum or buoyancy (i.e., the plume centerline heights are at ground-level). The air strippers will also be modeled, in this preliminary baseline risk assessment, as area sources (see Section 1.5).

There was large spatial distribution of the sources, and each was modeled separately. Impacts were then summed to estimate cumulative impacts at the nearest town boundaries of Grantsville, Tooele, and Stockton. The locations conservatively represent the most exposed individual at each town. For a risk assessment at residential locations, 30-year-average impacts were estimated.

#### 3.1.1 ISCST Model

The Industrial Source Complex Short Term (ISCST) dispersion model dated 90346 was used in a screening mode to conservatively estimate the air-quality impacts associated with air emissions from the Site/SWMUs and air strippers. ISCST is a Gaussian-plume model and is listed in USEPA's *Guideline on Air Quality Models (Revised)* (EPA-450/2-78-027R, July 1986 and Supplement A, July 1987) as an approved model for regulatory applications. A new version of ISCST has recently been released; however, it is not being used here in order to maintain consistency with previous versions of this report.

ISCST is generally recommended for use where the elevation of receptors do not exceed the source height. For the TEAD-N facility, some receptors (e.g., the towns of Tooele and Stockton) are at elevations above the Sites/SWMUs and air strippers. ISCST was used without the terrain option (i.e., flat terrain was assumed). This assumption was conservative for these area sources since the plume heights are at ground-level of the sources; the same level assumed for the receptors. For a wind blowing from a source toward a receptor, a ground-level plume always results in maximum ground-level impacts.

Other ISCST-model options, relevant to area-source-screening applications, are shown in Table A-3. These correspond to regulatory default specifications. Other model options (not shown) were either not applicable to area-source-screening modeling or controlled the model output format.

In the screening mode, ISCST provided estimates of maximum 1-hour-average impacts. For estimating 30-year-average impacts, a scaling factor was developed from 1989 climatological data on wind direction for Grantsville, Utah. Wind-rose data indicated that the maximum annual frequency of occurrence of any wind direction was 14 percent for south-southwest winds. This frequency was used to conservatively represent the scaling factor to be applied to the 1-hour-average impacts for all source/receptor combinations (i.e., a scaling factor of 0.14).

*Table A-3. ISCST Model Options for TEAD-N Area Sources*

Concentrations calculated	ISW(1)	= 1
No receptor elevations read	ISW(4)	= 0
1-hour-average concentration computed	ISW(7)	= 1
Meteorology read from cards	ISW(19)	= 2
Rural option	ISW(20)	= 0
Default wind profile exponents	ISW(21)	= 1
Default vertical potential temp. gradients	ISW(22)	= 1
Emission rates do not vary	ISW(23)	= 0
Final plume rise	ISW(24)	= 1
Calms-adjustment option not used	ISW(27)	= 2
Pollutant type other than SO <sub>2</sub>	ISW(29)	= 2
No above-ground receptors	ISW(31)	= 0
Pollutant-decay rate equals zero	DECAY	= 0
Default-wind-speed categories	UCATS	= 0 or blank
Default-emission-rate conversion factor	TK	= 0 or blank

The same annual frequency of occurrence was assumed for each year over a 30-year period. Therefore, 1-hour-average impacts scaled by 0.14 represent 30-year-average impacts.

### 3.1.2 Source Data

The sources were modeled separately as area sources with ground-level-release heights. Only those with potential VOC emissions were modeled. Emission rates were assumed to be uniform over an area source.

ISCST has two requirements for area source modeling: individual area sources must have the same east-west and north-south dimensions (i.e., a square area), and the coordinates for the southwest corner of the area must be input to the model. For simplicity, each was modeled as a single square area centered on coordinate (0 km east, 0 km north). The dimensions, and therefore the southwest corner coordinates, were determined from the areas listed in Table A-1.

The length of each side was set equal to the square root of the area. The east and north coordinates for the southwest corner were both set to  $(-0.5 \times \text{length of a side})$ . This method for defining the location of an area source is appropriate for screening on an individual-source basis.

To minimize the dispersion-modeling effort, ISCST was run for each area source assuming a single pollutant had an emission rate of 1.0 microgram per square meter per second ( $\mu\text{g}/\text{m}^2 \cdot \text{sec}$ ). The resulting modeled impact was then scaled by the actual pollutant-emission rates from the Sites/SWMUs to estimate the pollutant-specific impacts. The pollutant-emission rates estimated from the CHEMDAT7 model are listed in Appendix A-1. The 30-year-average

emission rates were used for estimating these off-site residential impacts. The emission rate for the air strippers is given in Section 1.5.

### 3.1.3 Meteorological Data

Meteorological input to ISCST in the screening mode for long-term (annual or longer) impacts included neutral atmospheric stability and a range of wind speeds. Other atmospheric stabilities (i.e., stable and unstable) were not considered since these are not representative of annual average conditions. Generally, stable conditions occur only during the nighttime hours and unstable conditions occur mainly during daytime conditions.

The wind speed/stability combinations used in the ISCST modeling are listed in Table A-4. Also, the mixing height was set to a constant value of 5,000 meters (m), the ambient temperature was set to a constant value of 293 °K (68 °F), and the wind direction was held constant along a radial from the source toward the receptors. All receptors were assumed to lie on this radial that originates at the center of the area source.

*Table A-4. Range of Wind Speed and Stability for the ISCST Screening Analysis*

Pasquill-Gifford Stability Class <sup>a</sup>	Wind Speed (m/sec)
D	1, 2, 3, 4, 5, 8, 10, 15, 20

<sup>a</sup>Neutral atmospheric stability is classified as D stability under the Pasquill-Gifford stability classification system.

### 3.1.4 Receptors

In order to estimate maximum impacts at the nearby towns, three receptors were chosen for each area source. These represent the shortest distance from a source to the boundary of Grantsville, the boundary of Tooele, and the boundary of Stockton.

For screening modeling of each source, the respective receptors were represented as discrete points along a single radial extending downwind from and to the east of the source. The radial originated at the center of the source and represented the wind-flow vector for the screening meteorological data set. The distance at which the receptors were placed depended on the actual distance from the source. In all cases, the receptor elevations were assumed to be the same as the source elevations. This resulted in the most conservative impact estimates.



### 3.1.5 ISCST Model Results

For each modeled source, the ISCST model-estimated 1-hour-average impacts at each receptor are shown in Table A-5. These impacts are based on the unit emission rate of  $1.0 \mu\text{g}/\text{m}^2 \cdot \text{sec}$ .

*Table A-5. ISCST Model-Estimated 1-Hour-Average Impacts for Scenario 1*

Site/SWMU #	1-Hour-Average Impact* ( $\mu\text{g}/\text{m}^3$ per $\mu\text{g}/\text{m}^2 \cdot \text{sec}$ )		
	Grantsville	Tooele	Stockton
1	0.50	0.25	0.34
10	0.72	1.08	1.17
11	0.72	1.08	1.17
29	0.56	4.72	0.79
30	0.37	1.84	0.32
Air Strippers	0.00035	0.00043	0.00010

\*Impacts are based on an area source emission rate of  $1.0 \mu\text{g}/\text{m}^2 \cdot \text{sec}$ .

The pollutant-specific 30-year-average impacts for each receptor were calculated as

$$\left[ \begin{array}{c} \text{30-year} \\ \text{average} \\ \text{impact} \end{array} \right] = \left[ \begin{array}{c} \text{30-year} \\ \text{average} \\ \text{emission rate} \end{array} \right] \times \left[ \begin{array}{c} \text{ISCST} \\ \text{1-hour} \\ \text{impact} \end{array} \right] \times \left[ \begin{array}{c} \text{0.14} \\ \text{scaling} \\ \text{factor} \end{array} \right] \quad (\text{Equation 1})$$

Based on the emission rate given for the air strippers and the 30-year-average emission rates generated from the CHEMDAT7 model (see Section 2 and Appendix A-1) and Equation 1, the 30-year-average impacts identified for each source are shown in Table A-6. The air-quality impact estimates are presented individually by source and receptor. Cumulative impacts are presented in Section 3.5.

### 3.2 SCENARIO 2: FUTURE ON-SITE RESIDENTIAL

Sites/SWMUs with surficial VOC emissions (1,10,11,29, and 30) were considered to be potential locations for future residences. Air-quality impacts at each Site/SWMU were based on emission rates from that Site/SWMU only. Cumulative impacts were not considered. The

assumption here is that a Site/SWMU is the most significant contributor to its own air quality. For a risk assessment at future residential locations, 30-year-average impacts were estimated.

### **3.2.1 Box Model**

The box-model approach is based on emissions into a volume of air with no lateral dispersion and a uniform distribution of contaminants in the vertical. In this case, the box is defined as a 1-cubic-meter volume immediately downwind of the center of the area source. The area source emission rate from CHEMDAT7 in terms of mass per unit time per unit area (i.e.,  $\mu\text{g}/\text{m}^2 \cdot \text{sec}$ ) mixed into this lowest 1 meter of air results in a volumetric emission rate ( $\mu\text{g}/\text{m}^3 \cdot \text{sec}$ ) into the box. The emission rate into the upwind side of the box is therefore equal to the area-source emission rate. The emissions are then diluted by the wind carrying the contaminant through the box.

To define the average concentration within the box (in  $\mu\text{g}/\text{m}^3$ ), the area-source-emission rate (in  $\mu\text{g}/\text{m}^2 \cdot \text{sec}$ ) is simply divided by the average wind speed (in m/sec). Using a 30-year-average-emission rate and an annual wind speed will result in a 30-year average concentration (i.e., the annual-average wind speed is constant from year to year).

### **3.2.2 Source Data**

Source data for the future on-site residential scenario included 30-year (262,800-hour) average emission rates from the CHEMDAT7 model. These emission rates are listed in Appendix A-1.

### **3.2.3 Meteorological Data**

The meteorological datum used as input to the box model was the annual-average wind speed for the TEAD-N facility. The annual-average wind speed was determined to be 4.2 m/sec (or 9.4 miles per hour) based on 1989 wind-rose data from Grantsville, Utah (0.8 km to the north of the TEAD-N facility).

### **3.2.4 Receptors**

Since it was assumed that future residences may be constructed on any of the contaminated Sites/SWMUs, these Sites/SWMUs were identified as the receptors.

Table A-6. Off-Site Residential Scenario—30-Year-Average Impacts

Site/SWMU #	Contaminant	30-year-average impact* ( $\mu\text{g}/\text{m}^3$ )		
		Grantsville	Tooele	Stockton
1	2,4,6-trinitrotoluene (TNT)	$5.41 \times 10^{-6}$	$2.71 \times 10^{-6}$	$3.68 \times 10^{-6}$
	2,4-dinitrotoluene (DNT)	$1.04 \times 10^{-5}$	$5.20 \times 10^{-6}$	$7.07 \times 10^{-6}$
	2,6-DNT	$1.48 \times 10^{-4}$	$7.40 \times 10^{-5}$	$1.01 \times 10^{-4}$
	HMX	$4.22 \times 10^{-13}$	$2.11 \times 10^{-13}$	$2.87 \times 10^{-13}$
	tetryl	$3.93 \times 10^{-9}$	$1.97 \times 10^{-9}$	$2.67 \times 10^{-9}$
10	1,3,5-trinitrobenzene	$2.45 \times 10^{-3}$	$3.67 \times 10^{-3}$	$3.98 \times 10^{-3}$
	2,4-DNT	$4.99 \times 10^{-5}$	$7.48 \times 10^{-5}$	$8.10 \times 10^{-5}$
	2,4,6-TNT	$1.35 \times 10^{-3}$	$2.03 \times 10^{-3}$	$2.20 \times 10^{-3}$
	HMX	$1.03 \times 10^{-12}$	$1.54 \times 10^{-12}$	$1.67 \times 10^{-12}$
11	1,3,5-trinitrobenzene	$2.45 \times 10^{-3}$	$3.67 \times 10^{-3}$	$3.98 \times 10^{-3}$
	2,4-DNT	$4.99 \times 10^{-5}$	$7.48 \times 10^{-5}$	$8.10 \times 10^{-5}$
	2,4,6-TNT	$1.35 \times 10^{-3}$	$2.03 \times 10^{-3}$	$2.20 \times 10^{-3}$
	HMX	$1.03 \times 10^{-12}$	$1.54 \times 10^{-12}$	$1.67 \times 10^{-12}$
29	benzo (a) anthracene	$1.11 \times 10^{-8}$	$9.38 \times 10^{-8}$	$1.57 \times 10^{-8}$
	benzo (a) pyrene	$1.08 \times 10^{-6}$	$9.12 \times 10^{-6}$	$1.53 \times 10^{-6}$
	benzo (b) fluoranthene	$2.33 \times 10^{-11}$	$1.96 \times 10^{-10}$	$3.28 \times 10^{-11}$
	chrysene	$3.65 \times 10^{-10}$	$3.08 \times 10^{-9}$	$5.15 \times 10^{-10}$
	fluoranthene	$4.52 \times 10^{-6}$	$3.81 \times 10^{-5}$	$6.38 \times 10^{-6}$
	phenanthrene	$2.41 \times 10^{-5}$	$2.03 \times 10^{-4}$	$3.40 \times 10^{-5}$
	pyrene	$7.07 \times 10^{-9}$	$5.96 \times 10^{-8}$	$9.98 \times 10^{-9}$
30	1,1,1-trichloroethane (TCA)	$2.63 \times 10^{-3}$	$1.30 \times 10^{-2}$	$2.26 \times 10^{-3}$
	carbon tetrachloride	$9.01 \times 10^{-4}$	$4.48 \times 10^{-3}$	$7.80 \times 10^{-4}$
	ethylbenzene	$2.93 \times 10^{-5}$	$1.46 \times 10^{-4}$	$2.54 \times 10^{-5}$
	tetrachloroethylene	$9.12 \times 10^{-4}$	$4.53 \times 10^{-3}$	$7.88 \times 10^{-4}$
	toluene	$7.67 \times 10^{-4}$	$3.81 \times 10^{-3}$	$6.63 \times 10^{-4}$
	trichloroethylene	$7.15 \times 10^{-6}$	$3.55 \times 10^{-5}$	$6.18 \times 10^{-6}$
Air Strippers	trichloroethylene	$3.94 \times 10^{+1}$	$4.84 \times 10^{+1}$	$1.13 \times 10^{+1}$

\*Impacts are based on Equation 1.

### **3.2.5 Model Results**

Thirty-year-average concentrations at Sites/SWMUs 1, 10, 11, 29, and 30 were estimated as the 30-year-average emission rates from CHEMDAT7 (see Appendix A-1) divided by the annual-average wind speed of 4.2 m/sec. Concentrations are shown for each Site/SWMU in Table A-7. Cumulative impacts were not considered for this scenario.

## **3.3 SCENARIO 3: ON-SITE WORKER EXPOSURE**

For the on-site worker-exposure scenario, only sites with VOC emissions that are within the industrial area of the TEAD-N facility (Sites/SWMUs 29 and 30) and the on-site vocational school were considered. Air-quality impacts at each location were estimated separately. Maximum-potential worker exposures for the industrial area were then estimated as the cumulative impacts from the two Sites/SWMUs. Since the vocational school is not located on a contaminated site, cumulative impacts from all Sites/SWMUs with surficial VOC contamination and the air strippers were estimated to address worker exposure at the school. For a risk assessment of worker exposure, 10-year-average impacts were estimated.

### **3.3.1 Box Model and ISCST Model**

The box-model approach was used for the on-site industrial-worker-exposure scenario. It was the same as that used for the future, on-site residential scenario (Scenario (2)) except that 10-year-average emission rates were used for each site/SWMU. This approach is defined in Section 3.2.1.

The ISCST model approach was used for the on-site vocational school worker exposure scenario. It was the same as that used for the off-site residential scenario (Scenario 1) except that 10-year-average emission rates were used for each site/SWMU. This approach is defined in Section 3.1.1.

### **3.3.2 Source Data**

The source data for the on-site worker exposure scenario included the 10-year (87,600-hour) average emission rates generated with the CHEMDAT7 model (see Section 2) for the Sites/SWMUs. These emission rates are listed in Appendix A-1. Source data for the air strippers are listed in Section 1.5.11

*Table A-7. Future On-Site Residential Scenario—30-Year-Average Impacts*

Site/SWMU #	Contaminant	30-year-average impact <sup>a</sup> (μg/m <sup>3</sup> )
1	2,4,6-trinitrotoluene (TNT)	$1.84 \times 10^{-5}$
	2,4-dinitrotoluene (DNT)	$3.55 \times 10^{-5}$
	2,6-DNT	$5.05 \times 10^{-4}$
	HMX	$1.44 \times 10^{-12}$
	tetryl	$1.34 \times 10^{-8}$
10	1,3,5-trinitrobenzene	$5.79 \times 10^{-3}$
	2,4-DNT	$1.18 \times 10^{-4}$
	2,4,6-TNT	$3.19 \times 10^{-3}$
	HMX	$2.43 \times 10^{-12}$
11	1,3,5-trinitrobenzene	$5.79 \times 10^{-3}$
	2,4-DNT	$1.18 \times 10^{-4}$
	2,4,6-TNT	$3.19 \times 10^{-3}$
	HMX	$2.43 \times 10^{-12}$
29	benzo(a)anthracene	$3.38 \times 10^{-8}$
	benzo(a)pyrene	$3.29 \times 10^{-6}$
	benzo(b)fluoranthene	$7.07 \times 10^{-11}$
	chrysene	$1.11 \times 10^{-9}$
	fluoranthene	$1.37 \times 10^{-5}$
	phenanthrene	$7.31 \times 10^{-5}$
	pyrene	$2.15 \times 10^{-8}$
30	1,1,1-trichloroethane (TCA)	$4.14 \times 10^{-3}$
	carbon tetrachloride	$1.35 \times 10^{-4}$
	ethylbenzene	$4.19 \times 10^{-3}$
	tetrachloroethylene	$3.52 \times 10^{-3}$
	toluene	$1.20 \times 10^{-2}$
	trichloroethylene	$3.29 \times 10^{-5}$

<sup>a</sup>Impacts are based on the box model approach described in Section 3.2.1.

### 3.3.3 Meteorological Data

The meteorological datum used as input to the box model was the annual-average wind speed for the TEAD-N facility. The annual-average wind speed was determined to be 4.2 m/sec (see Section 3.2.3). The meteorological data used as input to the ISCST model are discussed in Section 3.1.3.

### 3.3.4 Receptors

For the on-site worker exposure scenario, the industrial area of the TEAD-N facility was considered as one receptor. Due to the concentrated spatial distribution of the contaminated Sites/SWMUs within this area, it was conservatively assumed that the Sites/SWMUs were collocated, and the receptor was located at the center of the Sites/SWMUs. The vocational school located in the southeastern corner of the TEAD-N facility was considered as the second receptor for this scenario.

*Table A-8. On-Site Worker Exposure Scenario—10-Year-Average Impacts*

<u>Site/SWMU #</u>	<u>Contaminant</u>	<u>10-year-average impact* (<math>\mu\text{g}/\text{m}^3</math>)</u>
29	benzo (a) anthracene	$5.10 \times 10^{-8}$
	benzo (a) pyrene	$5.69 \times 10^{-6}$
	benzo (b) fluoranthene	$7.33 \times 10^{-11}$
	chrysene	$1.20 \times 10^{-9}$
	fluoranthene	$2.38 \times 10^{-5}$
	phenanthrene	$1.26 \times 10^{-4}$
	pyrene	$2.55 \times 10^{-8}$
30	1,1,1-trichloroethane (TCA)	$2.08 \times 10^{-2}$
	carbon tetrachloride	$7.17 \times 10^{-3}$
	ethylbenzene	$2.33 \times 10^{-4}$
	tetrachloroethylene	$7.24 \times 10^{-3}$
	toluene	$6.12 \times 10^{-3}$
	trichloroethylene	$5.69 \times 10^{-5}$

\*Impacts are based on the box model approach described in Section 3.3.1.

### **3.3.5 Model Results**

Ten-year average concentrations at Sites/SWMUs 29 and 30 were estimated as the 10-year average emission rates from CHEMDAT7 (see Appendix A-1) divided by the annual average wind speed of 4.2 m/sec. These concentrations are shown for each Site/SWMUs in Table A-8. Cumulative impacts are presented in Section 3.5.

The ISCST model-estimated 1-hour-average impacts at the vocational school are shown for each source in Table A-9. These impacts are based on the unit emission rate of  $1.0 \mu\text{g}/\text{m}^2\cdot\text{sec}$ . Pollutant-specific, 10-year average impacts at the vocational school are presented in Section 3.5.

## **3.4 SCENARIO 4: CURRENT ON-SITE RESIDENTIAL**

The current on-site residential area consists of full-family-housing units and WHERRY-housing units located approximately 2 kilometers south of the TEAD-N industrial area. This housing is used by on-site personnel and their dependents. The average length of residence is 2 years for the Full Family housing and 1 year for the WHERRY housing. The length of exposure to contamination at the TEAD-N facility was conservatively assumed to be 10 years for residents in the on-site housing (the same length assumed for the on-site worker scenario).

For the purpose of risk assessment, impacts at the residential area were based on nearness of housing unit to each source, 10-year-average emission rates for each site/SWMU, and the air strippers.

### **3.4.1 ISCST Model**

The ISCST-model approach used for the current on-site residential exposure scenario was the same as that used for the off-site residential scenario (Scenario 1) except that 10-year-average emission rates were used for each site/SWMU. This approach is defined in Section 3.1.1.

### **3.4.2 Source Data**

The source data for the current residential scenario included the 10-year (87,600-hour) average emission rates generated with the CHEMDAT7 model (see Section 2) for the sites/SWMUs. These emission rates are listed in Appendix A-1. Source data for the air strippers are listed in Section 1.5.

**Table A-9. ISCST Model-Estimated 1-Hour-Average Impacts for Scenario 3**

1-hour-average impact* ( $\mu\text{g}/\text{m}^3$ per $\mu\text{g}/\text{m}^2\cdot\text{sec}$ )	
Site/SWMU	Vocational School
1	0.26
10	1.21
11	1.21
29	2.81
30	0.88
Air Strippers	0.00019

\*Impacts are based on an area source emission rate of  $1.0 \mu\text{g}/\text{m}^2\cdot\text{sec}$ .

### 3.4.3 Meteorological Data

Meteorological data used for input to the ISCST model are discussed in Section 3.1.3.

### 3.4.4 Receptors

The nearest housing unit to the sources was used as the receptor for this scenario.

### 3.4.5 Model Results

The ISCST-model estimate 1-hour average impacts at the current, on-site housing are shown for each source in Table A-10. These impacts are based on a unit emission rate of  $1.0 \mu\text{g}/\text{m}^2\cdot\text{sec}$ . Pollutant-specific, 10-year-average impacts at the housing area are presented in Section 3.5.



*Table A-10. ISCST-Model Estimated 1-Hour-Average Impacts for Scenario 4*

1-hour-average impact <sup>a</sup> ( $\mu\text{g}/\text{m}^3$ per $\mu\text{g}/\text{m}^2\cdot\text{sec}$ )	
Site/SWMU #	Current On-Site Housing
1	0.30
10	1.71
11	1.71
29	3.46
30	1.08
Air Strippers	0.00021

<sup>a</sup>Impacts are based on an area source emission rate of  $1.0 \mu\text{g}/\text{m}^2\cdot\text{sec}$

### 3.5 AIR-QUALITY-IMPACT SUMMARY

Impact estimates presented in Sections 3.1, 3.2, and 3.3 were used as input to a health-risk assessment to address possible long-term health effects of exposed individuals. The three scenarios evaluated were (1) off-site residential, (2) future on-site residential, and (3) on-site worker exposure. Scenarios 1 and 3 considered cumulative impacts. Scenario 2 considered individual Site/SWMU impacts only. These impacts are summarized in Table A-11.

## 4.0 CONFIDENCE LEVEL OF MODEL RESULTS

### 4.1 AIR-EMISSION ESTIMATES

The land-treatment model in CHEMDAT7 was used to estimate air emissions of the VOCs. Several assumptions were used with this model, which may tend to overestimate VOC emission rates for the TEAD-N facility. First, the model was developed primarily to estimate VOC air emissions from wastes spread onto or injected into the ground. It assumes a relatively frequent application of the wastes onto the land. The TEAD-N Sites/SWMUs contain a contaminated soil matrix that has been in place and undisturbed for many years. Consequently, the TEAD-N soil matrix is likely to be more stable than the soil matrix of a typical, active-land-treatment site.

Table A-11. Summary of Air-Quality Impacts Used in Risk Assessment

Pollutant	Scenario 1				Scenario 2			
	Grantsville	Tooele	Stockton	SWMU 1	SWMU 10	SWMU 11	SWMU 29	SWMU 30
	30-Year-Average Impact <sup>a</sup> ( $\mu\text{g}/\text{m}^3$ )				30-Year-Average Impact <sup>b</sup> ( $\mu\text{g}/\text{m}^3$ )			
Benzo(a)anthracene	$1.11 \times 10^{-4}$	$9.38 \times 10^{-4}$	$1.57 \times 10^{-4}$	-	-	-	$3.38 \times 10^{-4}$	-
Benzo(a)pyrene	$1.08 \times 10^{-4}$	$9.12 \times 10^{-4}$	$1.53 \times 10^{-4}$	-	-	-	$3.29 \times 10^{-4}$	-
Benzo(k)fluoranthene	$2.33 \times 10^{-11}$	$1.96 \times 10^{-10}$	$3.28 \times 10^{-11}$	-	-	-	$7.07 \times 10^{-11}$	-
Carbon tetrachloride	$2.95 \times 10^{-3}$	$1.08 \times 10^{-2}$	$1.92 \times 10^{-3}$	-	-	-	-	$4.14 \times 10^{-3}$
Chrysene	$3.65 \times 10^{-10}$	$3.08 \times 10^{-9}$	$5.15 \times 10^{-10}$	-	-	-	$1.11 \times 10^{-9}$	-
Dinitrotoluene(2,4)	$1.10 \times 10^{-4}$	$1.55 \times 10^{-4}$	$1.69 \times 10^{-4}$	$3.55 \times 10^{-5}$	$1.18 \times 10^{-4}$	$1.18 \times 10^{-4}$	-	-
Dinitrotoluene 2,6	$1.48 \times 10^{-4}$	$7.40 \times 10^{-5}$	$1.01 \times 10^{-4}$	$5.05 \times 10^{-4}$	-	-	-	-
Ethylbenzene	$9.59 \times 10^{-5}$	$3.52 \times 10^{-4}$	$6.26 \times 10^{-5}$	-	-	-	-	$1.35 \times 10^{-4}$
Fluoranthene	$4.52 \times 10^{-4}$	$3.81 \times 10^{-5}$	$6.38 \times 10^{-4}$	-	-	-	$1.37 \times 10^{-5}$	-
HMX	$2.42 \times 10^{-12}$	$3.29 \times 10^{-12}$	$3.63 \times 10^{-12}$	$1.44 \times 10^{-12}$	$2.43 \times 10^{-12}$	$2.43 \times 10^{-12}$	-	-
Phenanthrene	$2.41 \times 10^{-5}$	$2.03 \times 10^{-4}$	$3.40 \times 10^{-5}$	-	-	-	$7.31 \times 10^{-5}$	-
Pyrene	$7.07 \times 10^{-9}$	$5.69 \times 10^{-4}$	$9.98 \times 10^{-9}$	-	-	-	$2.15 \times 10^{-4}$	-
Tetrachloroethylene	$2.98 \times 10^{-3}$	$1.09 \times 10^{-2}$	$1.95 \times 10^{-3}$	-	-	-	-	$4.19 \times 10^{-3}$
Teteryl	$3.93 \times 10^{-9}$	$1.97 \times 10^{-9}$	$2.67 \times 10^{-9}$	$1.34 \times 10^{-4}$	-	-	-	-
Toluene	$2.51 \times 10^{-3}$	$9.20 \times 10^{-3}$	$1.64 \times 10^{-3}$	-	-	-	-	$3.52 \times 10^{-3}$
Trichloroethane(1,1,1)	$8.57 \times 10^{-3}$	$3.14 \times 10^{-2}$	$5.59 \times 10^{-3}$	-	-	-	-	$1.20 \times 10^{-2}$
Trichloroethylene	$3.94 \times 10^{-5}$	$4.84 \times 10^{-1}$	$1.53 \times 10^{-1}$	-	-	-	-	$3.29 \times 10^{-5}$
Trinitrobenzene,1,3,5-	$4.90 \times 10^{-3}$	$7.34 \times 10^{-3}$	$7.96 \times 10^{-3}$	-	$5.79 \times 10^{-3}$	$5.79 \times 10^{-3}$	-	-
Trinitrotoluene 2,4,6-	$2.71 \times 10^{-3}$	$4.06 \times 10^{-3}$	$4.40 \times 10^{-3}$	$1.84 \times 10^{-5}$	$3.19 \times 10^{-3}$	$3.19 \times 10^{-3}$	-	-

<sup>a</sup>Off-site, residential impacts at nearest town boundaries. Includes contribution from Sites/SWMUs 1, 10, 11, 29, and 30, and air strippers.

<sup>b</sup>On-site, future residential impacts at Sites/SWMUs. Contributions from other Sites/SWMUs are not included.

Table A-11. Summary of Air-Quality Impacts Used in Risk Assessment (continued)

Pollutant	Scenario 3		Scenario 4	
	10-Year-Average Impact <sup>a</sup> ( $\mu\text{g}/\text{m}^3$ )		10-Year-Average Impact <sup>a</sup> ( $\mu\text{g}/\text{m}^3$ )	
	SWMUs 29, 30	Vocational School	Current On-Site Housing	
Benzo(a)anthracene	$5.10 \times 10^{-4}$	$8.41 \times 10^{-4}$	$1.04 \times 10^{-7}$	
Benzo(a)pyrene	$5.69 \times 10^{-4}$	$9.41 \times 10^{-4}$	$1.16 \times 10^{-5}$	
Benzo(k)fluoranthene	$7.33 \times 10^{-11}$	$1.21 \times 10^{-10}$	$1.50 \times 10^{-10}$	
Carbon tetrachloride	$7.24 \times 10^{-3}$	$3.71 \times 10^{-3}$	$4.55 \times 10^{-3}$	
Chrysene	$1.20 \times 10^{-9}$	$1.99 \times 10^{-9}$	$2.45 \times 10^{-9}$	
Dinitrotoluene(2,4)	-	$3.00 \times 10^{-4}$	$4.20 \times 10^{-4}$	
Dinitrotoluene 2,6	-	$1.34 \times 10^{-4}$	$1.54 \times 10^{-4}$	
Ethylbenzene	$2.33 \times 10^{-4}$	$1.21 \times 10^{-4}$	$1.48 \times 10^{-4}$	
Fluoranthene	$2.38 \times 10^{-5}$	$3.93 \times 10^{-5}$	$4.84 \times 10^{-5}$	
HMX	-	$3.68 \times 10^{-12}$	$5.14 \times 10^{-12}$	
Phenanthrene	$1.26 \times 10^{-4}$	$2.09 \times 10^{-4}$	$2.56 \times 10^{-4}$	
Pyrene	$2.55 \times 10^{-4}$	$4.21 \times 10^{-4}$	$5.18 \times 10^{-4}$	
Tetrachloroethylene	$7.24 \times 10^{-3}$	$3.75 \times 10^{-3}$	$4.59 \times 10^{-3}$	
Tetral	-	$2.52 \times 10^{-9}$	$2.91 \times 10^{-9}$	
Toluene	$6.12 \times 10^{-3}$	$3.16 \times 10^{-3}$	$3.89 \times 10^{-3}$	
Trichloroethane(1,1,1)	$2.08 \times 10^{-2}$	$1.08 \times 10^{-2}$	$1.32 \times 10^{-2}$	
Trichloroethylene	$5.69 \times 10^{-5}$	$2.13 \times 10^{-11}$	$2.35 \times 10^{-11}$	
Trinitrobenzene, 1,3,5-	-	$1.43 \times 10^{-2}$	$2.02 \times 10^{-2}$	
Trinitrotoluene 2,4,6-	-	$7.06 \times 10^{-3}$	$9.97 \times 10^{-3}$	

<sup>a</sup>On-site worker exposure impacts at the industrial Sites/SWMUs. Includes contribution from Sites/SWMUs 29 and 30 for industrial site, and from all Sites/SWMUs and air strippers for the vocational school.

<sup>a</sup>Current, on-site residential impacts at the full family and WHERRY housing area. Includes contribution from all Sites/SWMUs and air strippers.

Second, most of the compounds at the TEAD-N Sites/SWMUs are present in low concentrations (i.e., <100 mg/kg soil). At these low concentrations, adsorption is an important factor that hinders volatilization. Although adsorption is considered by some of the CHEMDAT7 models, it is not included in the land-treatment model.

Third, the model is based on the assumption that the contaminants are in solution (oil) when applied to the soil. The most accurate estimate of the model-input oil term for the soil is the low-volatile organic fraction of the soil. Since this information was not readily available, the sum of the naturally occurring total organic carbon (TOC) content of the soil and the organic contaminants was assumed to constitute the oil. This likely resulted in underestimating the low-volatile organic fraction of the soil and, therefore, overestimating the concentration of the contaminants in the oil.

Each of the above conditions may result in overestimating VOC air-emission rates.

#### **4.2 AIR-QUALITY-IMPACT ESTIMATES**

Several assumptions used in the air-quality-impact analyses may tend to overestimate impacts. First, ISCST in a screening mode reports maximum 1-hour-average impacts based on assumed meteorological conditions. A scaling factor based on maximum frequency of occurrence of wind direction is then applied to convert the maximum 1-hour impacts to annual average or longer period impacts. Although this approach is consistent with USEPA guidance for screening, it represents a possible overestimation of impacts since the same scaling factor is used regardless of direction from a source to a receptor.

Second, the emission-rate estimates used in the dispersion modeling were based on a single soil sample from each Site/SWMU. This assumed that the emission rates, expressed as  $\mu\text{g}/\text{m}^2 \cdot \text{sec}$ , were representative for the entire contaminated area of a Site/SWMU. If the soil sample was from a significantly contaminated area of a Site/SWMU and the Site/SWMU was not uniformly contaminated, this assumption will lead to an overestimation of impacts.

Third, the maximum-air-quality impacts identified for each town (Grantsville, Tooele, and Stockton) are based on the closest town boundaries to the Site/SWMU, not the closest residence in these towns.

Fourth, the air strippers were conservatively modeled as a ground-level-area source due to inadequate source data, even though the emission release height is 50 feet.

Each of the above conditions may result in overestimating the air quality impacts caused by the TEAD-N facility.

### **4.3 SUMMARY**

Since these types of models are generally used as tools to safeguard the environment and public health, they are developed to provide conservative estimates. Considering the additional conservative assumptions applied in this analysis, it is believed that the estimated air-quality impacts at each receptor include a significant margin of safety.



**APPENDIX A-1**

**CHEMDAT7 MODEL AIR EMISSION ESTIMATES**





SWMU 1

LAND TREATMENT MODEL DATA

(land treatment)	
L, Loading (g oil/cc soil)	0.007482
Concentration in oil(ppmw)	0
l, Depth of tilling (cm)	152.4
Total porosity	0.5
Air Porosity(0 if unknown)	0
MW oil	300
For aqueous waste, enter 1	0
Time of calc. (days)	365.25
For biodegradation, enter 1	0
Temperature (Deg. C)	25
Wind Speed (m/s)	4.2
Area (m2)	68423

COMPOUND NAME	LANDTREATMENT EMISSION RATES (g/cm2-s)	
	TIME (hours)	
	87600	262800
DINITROTOLUENE 2,6	3.67E-13	2.12E-13
DINITROTOLUENE(2,4)	2.57E-14	1.49E-14
HMX	6.04E-22	6.03E-22
TETRYL	6.94E-18	5.61E-18
TRINITROTOLUENE 2,4,6-	1.27E-14	7.73E-15

SWMUs 2,30

LAND TREATMENT MODEL DATA

(land treatment)	
L, Loading (g oil/cc soil)	0.007482
Concentration in oil (ppmw)	0
l, Depth of tilling (cm)	152.4
Total porosity	0.5
Air Porosity (0 if unknown)	0
MW oil	300
For aqueous waste, enter 1	0
Time of calc. (days)	365.25
For biodegradation, enter 1	0
Temperature (Deg. C)	25
Wind Speed (m/s)	4.2
Area (m2)	81770

LANDTREATMENT EMISSION RATES (g/cm2-s)

COMPOUND NAME	TIME (hours)	
	87600	262800
CARBON TETRACHLORIDE	3.01E-12	1.74E-12
ETHYLBENZENE	9.79E-14	5.66E-14
TETRACHLOROETHYLENE	3.04E-12	1.76E-12
TOLUENE	2.57E-12	1.48E-12
TRICHLOROETHANE(1,1,1)	8.74E-12	5.05E-12
TRICHLOROETHYLENE	2.39E-14	1.38E-14

SWMUs 10, 11

LAND TREATMENT MODEL DATA

(land treatment)	
L, Loading (g oil/cc soil)	0.03
Concentration in oil (ppmw)	0
l, Depth of tilling (cm)	152.4
Total porosity	0.5
Air Porosity (0 if unknown)	0
MW oil	245
For aqueous waste, enter 1	0
Time of calc. (days)	365.25
For biodegradation, enter 1	0
Temperature (Deg. C)	25
Wind Speed (m/s)	4.2
Area (m2)	97913

LANDTREATMENT EMISSION RATES (g/cm2-s)

COMPOUND NAME	TIME (hours)	
	87600	262800
DINITROBENZENE M	1.15E-13	6.67E-14
DINITROTOLUENE (2,4)	8.55E-14	4.95E-14
HMX	1.02E-21	1.02E-21
NITROBENZENE	4.53E-13	2.61E-13
TRINITROBENZENE, 1,3,5-	4.20E-12	2.43E-12
TRINITROTOLUENE 2,4,6-	2.08E-12	1.34E-12

SWMU 29

LAND TREATMENT MODEL DATA

(land treatment)

L, Loading (g oil/cc soil)	0.007482
Concentration in oil (ppmw)	0
l, Depth of tilling (cm)	152.4
Total porosity	0.5
Air Porosity (0 if unknown)	0
MW oil	300
For aqueous waste, enter 1	0
Time of calc. (days)	365.25
For biodegradation, enter 1	0
Temperature (Deg. C)	25
Wind Speed (m/s)	4.2
Area (m2)	25000

LANDTREATMENT EMISSION RATES (g/cm2-s)

COMPOUND NAME	TIME (hours)	
	87600	262800

BENZO(A)ANTHRACENE	6.62E-15	4.39E-15
BENZO(A)PYRENE	1.46E-13	8.45E-14
BENZO(k)FLUORANTHENE	5.21E-19	5.03E-19
CHRYSENE	6.14E-17	5.67E-17
FLUORANTHENE	7.56E-13	4.37E-13
PHENANTHRENE	2.84E-13	1.65E-13
PYRENE	0.00E+00	0.00E+00

## **APPENDIX B**

### **GROUNDWATER MONITORING**



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## **Appendix B**

### **Acronyms/Abbreviations**

$f_{oc}$	fraction organic compound
$K_d$	distribution coefficient
$K_{oc}$	soil adsorption coefficient
MCLG	Maximum Contaminant Level Goal
RDX	cyclonite



## **APPENDIX B GROUNDWATER MODELING**

Groundwater modeling was conducted to estimate contaminant concentrations at potential exposure points downgradient of the Tooele North Army Depot. This appendix describes the methods used to conduct the modeling, assumptions incorporated into the modeling, and results generated by the groundwater modeling.

### **1.0 SITE/SWMU DESCRIPTION**

A list of Sites/SWMUs included in the groundwater modeling and constituents modeled at each site are presented in Table B-1. Modeling was conducted only at those sites for which groundwater analytical data were available. Sites/SWMUs for which no groundwater data are available were omitted from the groundwater-modeling effort. Where possible, multiple sites were grouped together to simplify the modeling process.

### **2.0 MODEL DESCRIPTION, INPUT PARAMETERS, AND ASSUMPTIONS**

An analytical model was used for the risk-assessment potential-exposure-point-concentration calculations. A general description of the model is provided in this section. A description of values for various aquifer characteristics used in the model and the site-specific assumptions inherent in the model are also provided.

#### **2.1 ANALYTICAL MODEL**

CONMIG, William C. Walton, 1989, was used for the groundwater-modeling calculations. CONMIG is an analytical model simulating two-dimensional contaminant transport in a one-dimensional flow field. The model assumes steady-state groundwater flow in one direction, constant dispersion properties in space and time, uniform contaminant concentrations vertically within the aquifer, negligible density and viscosity differences between injected and native water, and a horizontal flow field. The model can take into account advection, adsorption, and dispersion of contaminants migrating through the aquifer.

Analytical-contaminant-transport models are based on ideal aquifer and solute conditions that generally limit model applicability for determining quantitative-contaminant-concentration distributions. Use of an analytical model is considered suitable for this assessment because of the limited amount of hydrogeologic and analytical data available for many of the sites. Available data would not support construction of a numerical model for the entire Tooele North area. Also, the preliminary nature of this risk assessment does not warrant the detail incorporated into a numerical contaminant-transport model.



## **2.2 SELECTION OF MODEL INPUT PARAMETERS**

Minimal specific information on aquifer physical characteristics and parameters is available for certain areas of the Tooele North Depot site outside the vicinity of the Industrial Waste Lagoon. Therefore, information on aquifer characteristics and parameters used in the model were taken primarily from the Groundwater Quality Assessment report (James M. Montgomery Consulting Engineers, [JMM], Inc., 1988). Average values reported in the Groundwater Quality Assessment document are considered, for purposes of this preliminary evaluation, to represent the best available parameter estimates for the entire area of the Tooele North Depot. A brief description of the information used to determine the input parameters to the model is given below.

### **2.2.1 Actual and Effective Porosity**

A porosity value of 0.25 was considered representative in the Ground Water Quality Assessment (see pages 4-20 and 5-31) and was used for groundwater-flow-velocity calculations. For purposes of these calculations, actual and effective porosity are considered to be equal.

### **2.2.2 Aquifer Thickness**

Aquifer thickness is 335 feet, based on location of the water table at a depth of approximately 225 feet below ground surface (see page 9 in Appendix C, Groundwater Quality Assessment).

### **2.2.3 Groundwater-Flow Velocity**

Calculated groundwater-flow velocities range from 4 feet per year to 9,800 feet per year (see pages 4-20, Groundwater Quality Assessment), with a value of 1,500 feet per year considered to represent an average velocity throughout a 50-foot screened interval of the alluvium. A value of 1,800 feet per year or 4.93 feet per day was determined through preliminary model runs to be considered a representative velocity value. This is used as a conservative value for calculating concentrations at downgradient exposure points.

### **2.2.4 Fraction Organic Carbon**

The Groundwater Quality Assessment reported that a fraction organic carbon ( $f_{oc}$ ) of 0.1 to 0.5 percent would be expected in the alluvial aquifer materials (see page 5-31). A value of 0.1 is used in the exposure-point calculations.

### **2.2.5 Bulk Density**

An assumed value of 2.65 g/cm<sup>3</sup> was considered representative in the Groundwater Quality Assessment report (see page 5-31). A measured value of 2.634 g/cm<sup>3</sup> was reported in the

Tooele Army Depot PA/SI, 1988 (see page 6-8). The value of 2.634 is used in the model calculations.

### 2.2.6 Dispersivity

Mercer and others report dispersivity values ranging from approximately 50 feet to over 600 feet for longitudinal dispersivity and approximately 10 feet to over 100 feet for transverse dispersivity in alluvial materials (J.W. Mercer et.al., 1982). The TCE plume at the IWL extends over 14,000 feet in the longitudinal direction. A maximum longitudinal dispersivity of 300 feet is therefore assumed (William C. Walton, 1989), while a transverse dispersivity of 30 feet (0.1 of the longitudinal dispersivity) is assumed.

### 2.2.7 Distribution coefficient ( $K_d$ )

Distribution coefficient values ( $K_d$ ) for organics may be predicted on the basis of a non-soil-specific parameter known as the organic-matter-partitioning coefficient, where  $K_{oc}$ .  $K_d$  values were calculated using the equation:

$$K_d = K_{oc} * f_{oc}.$$

Soil-solution-distribution coefficients for inorganic chemicals were estimated based on literature values compiled in E.I. duPont de Nemours and Co., 1987. Distribution coefficient values for parameters modeled in the risk assessment are presented in Table 1.

Source Volume. Source-term volumes were assumed to be equal to the specific discharge through one vertical cross-sectional area of the model grid.

Initial Concentration. Maximum constituent concentrations in groundwater from wells directly downgradient or in close proximity to each site were selected for the initial source concentrations input to the model. These concentrations, however, may not be representative of impacts solely from a single site. Because many of the sites are in close spatial proximity to one another, groundwater monitored by a single monitoring well may be impacted by more than one site. Ultimately, a comparison of monitoring-well results to constituents detected in soil samples from each site would aid in determining which sites may be contributing contaminants detected in specific monitoring wells.

## 2.3 MODEL APPLICATION

Data describing aquifer characteristics are not uniformly available across the entire Tooele North Depot. Therefore, groundwater modeling for this preliminary risk assessment assumes that the

aquifer system underlying the Depot can be simplified to a single aquifer system having uniform spatial characteristics. Aquifer physical properties were assumed to be the same for each site modeled.

This simplified approach allows application of the analytical model CONMIG. Use of variable aquifer properties and characteristics would require the application of more complex numerical models and would require data on the spatial variability of aquifer parameters across the Depot. This level of complexity is not warranted in a preliminary risk assessment.

For application of CONMIG, it was assumed that a uniform one-directional flow field exists between the contaminant source (Site/SWMU) and the identified potential point of exposure. Variations in groundwater-flow direction, such as from seasonal recharge or pumping of water supply wells, were not incorporated into the modeling though it is anticipated that such variations exist. However, assumption of a direct flow path between the source (site) and potential exposure points (receptors) results in a worst-case scenario for contaminant transport (i.e., the most direct path and shortest route of travel). This assumption, though not realistic for all potential exposure points, is considered acceptable for this preliminary risk assessment.

### **3.0 IDENTIFICATION OF POTENTIAL GROUNDWATER EXPOSURE POINTS**

The Tooele North Army Depot has at least seven water supply wells identified within the Depot boundaries (CNES, Final Field Sampling Plan, March 1992, Figure 3). Wells WW-1 through WW-3 are currently used as a source water for process and consumptive uses. According to TEAD-N personnel, the water is treated to meet MCL prior to use. Therefore, the groundwater pathway for on-site worker exposure is considered incomplete, and potential exposure points for human ingestion of groundwater were identified off-site in the general direction of groundwater flow to the north, downgradient from the Tooele Depot.

A well-inventoried printout from the State of Utah was used to identify water-supply wells present downgradient from the Depot. The identified wells were assumed, for purposes of this preliminary risk assessment, to be domestic water-supply wells. Many of these wells, in actuality, may be irrigation or stock wells and would not serve as a source of water for human consumption.

The parameters modeled for each site, including the MCL, the Maximum Contaminant Level Goal (MCLG), the Utah Class 2 standard, the initial concentration, and the description of each off-site well are included in Tables 2 through 4.

#### **3.1 SITE/SWMU 1**

For Site/SWMU 1, the concentration of nitrate/nitrite was estimated at five off-site wells (Wells 16, 10, and City of Grantsville Wells 1, 2, and 3) located approximately 24,000 to 34,500 feet downgradient of the site. The City of Grantsville wells are not the closest potential groundwater exposure points to Site/SWMU Number 1, but calculations of potential exposure-point

**Table B-2. Calculated Projected Exposure-Point Concentrations Site/SWMU 1**

Concentrations in ug/l.

INORGANICS									
Parameter	MCL	MCLG	UTAH Class II*	INITIAL	Well 16	Well 10	Well 1	Well 2	Well 3
					FINAL	FINAL	FINAL	FINAL	FINAL
Nitrate/Nitrite (as N)	10,000/1000	10,000/1000	10,000/—	17500	0.07	3.2	2.7	3.01	0.5

WELL		UTM Coord.		Distance from		Remarks
NUMBER	T.R.Sect.	North	East	Site 1		
16	T3S,R5W,s7	4492041	377364	28,500		
10	T3S,R6W,s1	4492875	375290	31,500		Represents two adjacent wells, both identified as well
1	T2S,R6W,s36	4495182	375121	39,000		City of Grantsville well.
2	T3S,R6W,s1	4493152	374727	33,000		City of Grantsville well.
3	T2S,R5W,s31	4494545	376424	37,500		City of Grantsville well.

\* Drinking Water Quality Ground Water: 500 mg/L < TDS < 3000 mg/L.



**Table B-3. Calculated Projected Exposure-Point Concentrations Sites/SWMUs 10/11**

Concentrations in ug/l.

INORGANICS					
Parameter	MCL	MCLG	UTAH Class II*	SITES 10 & 11	
				INITIAL	FINAL
Arsenic	50	--	50	110	0.0368
Copper	--	--	1000	33	0.0111
Fluoride	1400-2400	4000	2400	6640	2.03
Nitrate/Nitrite (as N)	10,000/1000	10,000/1000	10,000/--	61,000	20.82
Thallium	--	--	--	3.4	<0.005

**ORGANICS**

Parameter	MCL	MCLG	UTAH Class II*	SITES 10 & 11	
				INITIAL	FINAL
Benzyl alcohol	--	--	--	8	0
Bis(2-ethylhexyl)Phthalate	--	--	--	10	0
Cyclonite(RDX)	--	--	--	160	0.05
2,4-dinitrotoluene	--	--	--	20	0.01
HMX	--	--	--	17.6	0.01
2-methyl-4,6-dinitrophenol	--	--	--	27	0.01
Phenol	--	--	--	3	0
1,3,5-trinitrobenzene	--	--	--	100	0.03
2,4,6-TNT	--	--	--	37.4	0.01

Closest Potential Exposure Point:

Well Oy T 3 S, R 5 W, Section 8; UTM 4492494N, 378771E

Distance from Sites 10 and 11 = 28,000 ft

\* Drinking Water Quality Ground Water: 500 mg/L <TDS<3000 mg/L.

**Table B-4. Calculated Projected Exposure-Point Concentrations  
Sites/SWMUs 12, 14, and 15, Site/SWMU 29, and  
Sites/SWMUs 2 and 30**

Concentrations in ug/l.

<b>INORGANICS</b>									
<b>Parameter</b>	<b>MCL</b>	<b>MCLG</b>	<b>UTAH Class II*</b>	<b>Sites 12, 14, 15</b>		<b>Sites 29</b>		<b>Sites 2, 30</b>	
				<b>INITIAL</b>	<b>FINAL</b>	<b>INITIAL</b>	<b>FINAL</b>	<b>INITIAL</b>	<b>FINAL</b>
Beryllium	--	--	--	0.402	<0.005	1.61	<0.005		
Cadmium	10	--	10					12	0.002
Chromium	50	--	50	720	0.133	51.9	0.007		
Copper	--	--	1000	37.7	0.007				
Iron	--	--	--	1200	0.218			1600	0.29
Manganese	--	--	--	87	0.016			5400	1.06
Nickel	--	--	--	58.3	0.009	294	0.039		

**ORGANICS**

<b>Parameter</b>	<b>MCL</b>	<b>MCLG</b>	<b>UTAH Class II*</b>	<b>Sites 12, 14, 15</b>		<b>Sites 29</b>		<b>Sites 2, 30</b>	
				<b>INITIAL</b>	<b>FINAL</b>	<b>INITIAL</b>	<b>FINAL</b>	<b>INITIAL</b>	<b>FINAL</b>
Bis(2-ethylhexyl)Phthalate	--	--	--			790	0.105		
Carbon Tetrachloride	5	0	5					41	0.008
Cyclonite (RDX)	--	--	--	8.56	<0.005				
1,2-dichlorobenzene	--	--	--					0.8	<0.005
1,3-dichlorobenzene	--	--	--					0.2	<0.005
1,4-dichlorobenzene	75	75	75					0.4	<0.005
1,1-Dichloroethane	5	--	--					150	0.03
Toluene	--	--	--	1.1	<0.005				
1,1,1-Trichloroethane	200	200	200					200	0.04
Trichloroethene	5	0	5	47.6	0.007			250	0.048

Potential Point of Exposure:

Well 12, T 3 S, R 5 W, Sec. 11; UTM 4492525 N, 383068 E.

Distance from Sites 2,30=14,000 ft (approximate).

Distance from Sites 12, 14, 15 =19,000 ft (approximate).

Distance from Site 29=22,000 ft (approximate).

\* Drinking Water Quality Ground Water: 500 mg/L <TDS<3000 mg/L.

concentrations were nonetheless made for these municipal wells given their use and positions downgradient from Site/SWMU 1.

### **3.2 SITE/SWMUs 10/11**

The concentrations of arsenic; copper; nitrate/nitrite; fluoride; thallium; benzyl alcohol; phenol; bis(2-ethylhexyl)phthalate; HMX; cyclonite (RDX); 1,3,5-trinitrobenzene; 2,4,6-TNT; 2,4-dinitrotoluene; and 2-methyl-4,6-dinitrophenol; were estimated at Well OY, located off-site and approximately 28,000 feet downgradient of Sites/SWMUs 10 and 11.

### **3.3 SITES/SWMUs 2 AND 30, SITES/SWMUs 12,14, AND 15, AND SITE/SWMU 29**

A single well, Well 12, was used to estimate concentrations of selected parameters downgradient of Sites/SWMUs 2 and 30; Sites/SWMUs 12, 14, and 15; and Site/SWMU 29. The distance to the well varied from approximately 14,000 feet to 22,000 feet downgradient of the site, and the parameters modeled include beryllium; cadmium; chromium; copper; nickel; iron; manganese; carbon tetrachloride; bis(2-ethylhexyl)phthalate; toluene; trichloroethene; 1,1-dichloroethane; 1,1,1-trichloroethane; cyclonite (RDX); 1,2-dichlorobenzene; 1,3-dichlorobenzene; and 1,4-dichlorobenzene.

## **4.0 RESULTS**

Results of the groundwater modeling were used to calculate risk to human health from potential exposure to groundwater contaminants that may migrate off-site from the Tooele North Army Depot. Groundwater modeling results are presented in Tables 2 through 4 of this appendix. The final concentrations indicate the calculated potential exposure-point concentrations and should be considered to be only estimates, given the following uncertainties in the groundwater modeling:

- Aquifer parameters are assumed to be uniform across the Tooele Depot area, though properties such as hydraulic conductivity, aquifer thickness, fraction organic carbon, and others, may vary from the characteristics observed in the eastern portion of the Depot.
- Groundwater flow is assumed to be one-directional, without influences from pumping wells or seasonal recharge.
- Contaminant concentrations observed in monitoring wells may be the result of influences from more than one Site/SWMU; thus, initial concentrations modeled may not be truly representative of the single Site/SWMU for which the model calculations were done.
- Downgradient potential groundwater exposure points used for modeling purposes may not be wells supplying water for human consumption.
- Monitoring-well and potential exposure-point locations are approximate.

## 5.0 REFERENCES

- Chem-Nuclear Environmental Services (CNES), 1992. Tooele Army Depot-North Area, *Remedial Investigation/Feasibility Study*, Volume II, Final Field Sampling Plan, March 1992. Contract No. DAAA15-90-D-0007.
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## APPENDIX C

### POTENTIALLY OCCURRING PLANTS AND ANIMALS



Potential Plant Species for Tooele Army Depot - North

Species identified during RFI for Tooele South.

- Allium nevadense Watson, "Onion." Infrequent, pinon-juniper zone.
- Artemisia spinescens
- Artemisia tridentata Nuttall, "Big Sagebrush"
- Chaenactis stevioides Hooker & Arnott, "Pincushion." Desert soils in the warm river valleys.
- Chrysothamnus nauseosus (Pallas) Britton, ssp. leiospermus, "Rabbitbrush."
- Cirsium vulgare (Savi) Tenore, "Bull Thistle." Pasture weed.
- Crepis occidentalis Nuttall, "American Hawksbeard." Common in dry sagebrush areas.
- Psilochenia occidentalis Nuttall.
- Erigeron engelmannii Nelson, "Daisy."
- Erigeron flagellaris Gray, "Daisy." Dry montane meadows.
- Erigeron unbelatum
- Grindelia squarrosa (Pursh) Dunal, var. serrulata, "Gumweed."
- Haplopappus acaulis "Stemless Goldenweed"
- Stenotus acaulis Nuttall. Common on rimrock and dry hillsides.
- Helianthus annuus L., "Common Sunflower." Very abundant and variable native roadside weed.
- Lactuca serriola L., "Prickly Lettuce." Common weed in fields and gardens.
- Senecio multicapitatus Greenman, "Butterweed." Desert-steppe and pinon-juniper.
- Tetradymia glabrata
- Tetradymia spinosa Hooker & Arnott, "Cottonthorn." Clay soil, desert-steppe and lower sagebrush.
- Tragopogon dubius Scopoli ssp. major (Jacquin) Vollmann, "Oyster-plant." Ruderal weed in dry hot valleys
- Cryptantha humulis
- Cynoglossum officinale L., "Hound's Tongue." Eurasian weed in forest clearings in the mountains and along fence-rows.
- Capsella bursa-pastoris (L.) Medikus, "Shepard's Purse." Abundant weed in early spring in waste ground, gardens and roadsides.
- Chorispora tenella (Pallas) de Candolle, "Purple Mustard." An abundant early spring weed of fallow fields.
- Conringia orientalis (L.) Dumortier, "Hare's Ear." Locally abundant spring-flowering Eurasian weed. The large rounded entire, clasping based leaves and pale yellow flowers are diagnostic.
- Descurainia pinnata (Walter) Britton, "Tansy Mustard." Early spring weed of the valleys, replacing D. richardsonii at lower altitudes.
- Erysimum aperum (Nuttall) de Candolle, "Wallflower."
- Hutchinsia procumbens
- Lepidium densiflorum Schrader, "Peppergrass." Very common, especially in spring, lower

## Potential Plant Species for Tooele Army Depot - North

### Species identified during RFI for Tooele South.

valleys.

Lepidium montanum Nuttall var. montanum, "Peppergrass." Characteristic plant of the pinon-juniper, flowering from late spring through midsummer.

Lepidium perfoliatum L., "Clasping Pepper-Grass." Extremely abundant roadside weed in the warm valleys.

Lesquerella occidentalis

Sisymbrium altissimum L., "Jim Hill Mustard." Abundant ruderal weed at low altitudes.

Stanleya pinnata (Pursch) Britton, "Prince's Plume." common on seleniferous soils in the valleys. Presence of Stanleya is indicative of the poisonous element, selenium, in the soil.

Thelypodopsis vermicularis

Thelypodium saquitatum

Calochortus nuttallii Torrey & Gray, "Mariposa." Adobe hills in the lower valleys. Utah state flower.

Atriplex confertifolia (Torrey & Fremont) Watson, "Shad-scale, Saltbrush." Common on adobe hills.

Atriplex gardneri (Moquin) Stanley, "Shad-scale." Very common and variable in stature and leaf shape.

Atriplex rosea L., "Shad-scale, Saltbrush." Alkaline flats and roadsides.

Kochia americana Watson. Common on clay flats, lower river valleys.

Kochia scoparia

Salsola iberica

Sarcobatus vermiculatus (Hooker) Torrey, "Greasewood." Abundant on alkaline flats. A poisonous plant containing calcium oxalate, nevertheless a useful forage plant if the diet is mixed and sheep do not graze in pure stands.

Convolvulus arvensis L., "Creeping-Jenny." Common creeping weed on roadsides and in lawns, very difficult to eradicate because of its deep roots and brittle rhizomes.

Astragalus bekwith

Astragalus calycosus

Astragalus converlonius

Lathyrus brachycalyx

Melilotus alba Desrousseaux, "Sweet-Clover." Extensively planted for forage, erosion control, and as a honey plant.

Lupinus caudatus Kellogg. Common on sagebrush stands, plateaus.

Erodium cicutarium (L.) L'Heritier, "Crane's Bill, Filaree." One of the earliest flowering weeds of early spring in ruderal sites. Identified with purple flowers instead of pink.

Junens arcticus ssp. vallicola

Nepeta cataria L., "Catnip." Ruderal weed in gardens and shaded pastures on floodplains.

Acrolasia albicaulis (Douglas) Rydberg. Common in early spring at low altitudes including desert flats.



## Potential Plant Species for Tooele Army Depot - North

Species identified during RFI for Tooele South.

### Mentzelia albicaulis

Sphaeralcea coccinea (Nuttall) Rydberg ssp. dissecta (Nuttall) Kearney, Copper Mallow, "Globe Mallow." Roadsides and ruderal, often disturbed sites in the valleys.

Oenothera caespitosa Nuttall, "Evening-Primrose." Abundant on clay hills and sandy roadcuts in the valleys and canyons.

Eriogonum ovalifolium var. nevadensis Gandoger, "Wild Buckwheat." Sagebrush, benches pinon-juniper and adobe hills.

Rumex crispus L., "Curly Dock." Weed in wet ditches.

### Gilia aggregata

### Gilia leptomenia

Phlox hoodii Richardson ssp. canescens (Torrey & Gray) Wherry. Very common throughout, in sagebrush.

Phlox longifolia Nuttall. Abundant throughout on roadsides, adobe hills and sagebrush.

Agropyron cristatum ssp. desertorum.

### Bromus tectorum

Elymus elymoides (Rafinesque) Swezey, "Wild Rye."

### Elymus spicatus

Poa bulbosa L. "Bulbous Bluegrass." Commonly cult and spreading in dry land.

Poa compressa L., "Canada Bluegrass." common on dry hillsides.

Poa fendleriana (Steudel) Vasey, "Muttongrass."

Poa secunda Presl., "Bluegrass." Very common and variable on dry grassland and desert-steppe.

### Stipa hymenoides

### Ranunculus testiculatus

Padus virginiana (L.) Miller ssp. melanocarpa (Nelson) Weber, "Choke-Cherry." Along streams in the lower valleys.

### Prunus virginiana

Purshia mexicana var. stansburyana

Purshia tridentata (Pursh) de Candolle, "Bitterbrush." Abundant in rocky sagebrush and pinon-juniper.

Verbascum thapsus L., "Mullein." An abundant roadside weed.

Tamarix L. "Tamarish, Salt Cedar."

Ulmus pumila L., "Chinese Elm." This central asian import was brought here because of its drought hardiness. It has been extensively planted around homesteads for shade and shelter from wind. As the land was abandoned the elms have survived and now colonize floodplains in the vicinity.

Verbena bracteata Lagasca & Rodriguez, "Vervain." Ruderal weed.

Sabina osteosperma (Torrey) Antoine, "Utah Juniper." Pinon-juniper.

Ephedra viridis Coville, "Mormon Tea." Desert sites and high altitudes.

## Potential Plant Species for Tooele Army Depot - North

Species identified during RFI for Tooele South.

### Pinus monophylla

A search of our information revealed no known occurrences of federal candidate plants in either unit of the Tooele Army Depot. There is one record of the Category 2 candidate plant Cryptantha compacta about six miles south of the southern unit, in Section 33 of T7S R5W (SLM). Its habitat is given as a black sagebrush community on low tuffaceous hills. However, a comment in the record states that this occurrence is unverified and needs to be checked in the field (which we have never done). Most known occurrences of this plant are much farther to the southwest in the west-desert part of Utah. (Tuhy, Coordinator for Utah Natural Heritage Program)

## Potential Mammals for Tooele Army Depot - North

Species have not been verified to be present by field investigation.

Sorex merriami "Merrim's Shrew"  
Sorex vagrans "Vagrant Shrew"  
Sorex palustris "Water Shrew"  
Myotis lucifugus "Little Brown Myotis"  
Myotis evotis "Long-eared Myotis"  
Myotis volans "Long-legged Myotis"  
Myotis subulatus "Small-footed Myotis." Identified as Myotis leibii in the Audubon Society Field Guide to North American Mammals.  
Lasionycteris noctivagans "Silver-haired Bat"  
Pipistrellus hesperus "Western Pipistrelle"  
Eptesicus fuscus "Big Brown Bat"  
Nycteris cinereus "Hoary Bat." Identified as Lasiurus cinereus in the Audubon Society Field Guide to North American Mammals.  
Plecotus townsendii "Townsend's Big-eared Bat"  
Euderma maculatum "Spotted Bat"  
Antrozous pallidus "Pallid Bat"  
Tadarida brasiliensis "Brazilian Free-tailed Bat"  
Lepus californicus "Black-tailed Jackrabbit"  
Sylvilagus nuttallii "Nuttall's Cottontail"  
Sylvilagus audubonii "Desert Cottontail"  
Marmota flaviventris "Yellow-Bellied Marmot"  
Spermophilus townsendii "Townsend's Ground Squirrel"  
Spermophilus variegatus "Rock Squirrel"  
Spermophilus lateralis "Golden-Mantled Ground Squirrel"  
Ammospermophilus leucurus "Antelope Ground Squirrel"  
Eutamias minimus "Least Chipmunk"  
Eutamias umbrinus "Uinta Chipmunk"  
Eutamias dorsalis "Cliff Chipmunk"  
Thomomys talpoides "Northern Pocket Gopher"  
Thomomys umbrinus "Southern Pocket Gopher"  
Perognathus longimembris "Little Pocket Mouse"  
Perognathus formosus "Great-Basin Pocket Mouse"  
Microdipodops megacephalus "Dark Kangaroo Mouse"  
Dipodomys ordii "Ord's Kangaroo Rat"  
Dipodomys microps "Chisel-toothed Kangaroo Rat"  
Reithrodontomys megalotis "Western Harvest Mouse"  
Peromyscus crinitus "Canyon Mouse"  
Peromyscus maniculatus "Deer Mouse"  
Peromyscus truei "Pinyon Mouse"  
Onychomys leucogaster "Northern Grasshopper Mouse"

Potential Mammals for Tooele Army Depot - North

Species have not been verified to be present by field investigation.

Neotoma lepida "Desert Wood Rat"  
Neotoma cinerea "Bushy-tailed Wood Rat"  
Lagurus curtatus "Sagebrush Vole"  
Microtus pennsylvanicus "Meadow Vole"  
Microtus montanus "Mountain Vole"  
Microtus longicaudus "Long-tailed Vole"  
Rattus norvegicus "Norway Rat"  
Mus musculus "House Mouse"  
Zapus princeps "Western Jumping Mouse"  
Erethizon dorsatum "Porcupine"  
Canis latrans "Coyote"  
Vulpes macrotis "Kit Fox"  
Urocyon cinereoargenteus "Gray Fox"  
Bassariscus astutus "Ring-Tail"  
Procyon lotor "Raccoon"  
Mustela erminea "Ermine"  
Mustela frenata "Long-tailed Weasel"  
Taxidea taxus "Badger"  
Mephitis mephitis "Stripped Skunk"  
Spilogale putorius "Spotted Skunk"  
Felis rufus "Bobcat"  
Felis concolor "Mountain Lion"  
Odocoileus hemionus "Mule Deer"  
Antilocapra americana "Pronghorn Antelope"

## Potential Avian Species for Tooele Army Depot - North

Species and habitats have not been verified to be present by field investigation.

### Migrant Species

Aquila chrysaetos "Golden Eagle"

Circus cyaneus "Marsh Hawk"

Tachycineta thalassina "Violet-green Swallow"

Riparia riparia "Bark Swallow"

Petrochelidon pyrrhonota "Cliff Swallow"

Vermivora celata "Orange-crowned Warbler"

Dendroica petechia "Yellow Warbler"

Dendroica coronata "Yellow-rumped Warbler." The white-throated northern population with two white wing bars was formerly known as the "Myrtle Warbler"; the western race, with yellow throat and one broad white wing bar, was called "Audubon's Warbler." The two have been found to interbreed and are now considered one species, the Yellow-rumped Warbler.

Molothrus ater "Brown-headed Cowbird"

Piranga ludoviciana "Western Tanager"

Spinus tristis "American Goldfinch." Identified as Carduelis tristis in the Audubon Society Field Guide to North American Birds Western Birds.

Junco hyemalis "Slate-colored Junco"

Junco oreganus "Oregon Junco"

Spizella breweri "Brewer's Sparrow"

Zonotrichia leucophrys "White-crowned Sparrow"

Melospiza lincolni "Lincoln's Sparrow"

Buteo lagopus "Rough-legged Hawk"

Haliaeetus leucocephalus "Bald Eagle"

Bombycilla garrulus "Bohemian Waxwing"

Bombycilla cedrorum "Cedar Waxwing"

Hesperiphona vespertina "Evening Grosbeak"

Selasphorus rufus "Rufous Hummingbird"

Selasphorus platycercus "Broad-tailed Hummingbird"

Regulus satrapa "Golden-crowned Kinglet"

Vireo solitarius "Solitary Vireo"

Falco peregrinus "Peregrine Falcon"

Charadrius alexandrinus "Snowy Plover"

Numenius americanus "Long-billed Curlew"

### Resident Species

Cathartes aura "Turkey Vulture"

Accipiter striatus "Sharp-shinned Hawk"

## Potential Avian Species for Tooele Army Depot - North

Species and habitats have not been verified to be present by field investigation.

Accipiter cooperii "Cooper's Hawk"  
Buteo swainsoni "Swainson's Hawk"  
Buteo jamaicensis "Red-tailed Hawk"  
Buteo regalis "Ferruginous Hawk"  
Falco sparverius "Sparrow Hawk"  
Falco mexicanus "Prairie Falcon"  
Zenaida macroura "Mourning Dove"  
Chordeiles minor "Common Nighthawk"  
Tyrannus verticalis "Western Kingbird"  
Myiarchus cinerascens "Ash-throated Flycatcher"  
Sayornis saya "Say's Phoebe"  
Hirundo rustica "Barn Swallow"  
Troglodytes aedon "House Wren"  
Mimus polyglottos "Mockingbird"  
Oreoscoptes montanus "Sage Thrasher"  
Turdus migratorius "Robin"  
Pipilo chlorurus "Green-tailed Towhee"  
Poocetes gramineus "Vesper Sparrow"  
Chondestes grammacus "Lark Sparrow"  
Centrocercus urophasianus "Sage Grouse"  
Phasianus colchicus "Ring-Necked Pheasant"  
Alectoris chukar "Chuckar"  
Bubo virginianus "Great Horned Owl"  
Speotyto cunicularia "Burrowing Owl." Identified as Athene cunicularia in the Audubon Society Field Guide to North American Birds Western Birds.  
Asio otus "Long-eared Owl"  
Asio flammeus "Short-eared Owl"  
Colaptes auratus "Red-shafted Flicker"  
Eremophila alpestris "Horned Lark"  
Aphelocoma coerulescens "Scrub Jay"  
Pica pica "Black-Billed Magpie"  
Corvus corax "Common Raven"  
Gymnorhinus cyanocephalus "Pinon Jay"  
Lanius ludovicianus "Loggerhead Shrike"  
Sturnus vulgaris "Starling"  
Passer domesticus "House Sparrow"  
Sturnella neglecta "Western Meadowlark"  
Agelaius phoeniceus "Red-winged Blackbird"  
Euphagus cyanocephalus "Brewer's Blackbird"  
Spizella passerina "Chipping Sparrow"

### Potential Avian Species for Tooele Army Depot - North

Species and habitats have not been verified to be present by field investigation.

#### Habitats of Concern

Shore Lines - Serve as alternating nesting habitats for shore birds during periods of high water in the Great Salt Lake.

Muddy Flats - Nesting habitat for candidate species such as the "Snowy Plover."





**APPENDIX D**

**TOXICITY PROFILES**



## **Appendix D**

### **Acronyms/Abbreviations**

<b>BCF</b>	<b>bioaccumulation factor</b>
<b>Hc</b>	<b>Henry's Constant Law</b>
<b>LOAEL</b>	<b>Low Observed Adverse Effect Level</b>
<b>NOAEL</b>	<b>No Observed Adverse Effect Level</b>
<b>PAH</b>	<b>polycyclic aromatic hydrocarbons</b>
<b>PCE</b>	<b>perchloroethylene</b>
<b>PVC</b>	<b>polyvinyl chloride</b>
<b>TCE</b>	<b>trichloroethene</b>
<b>TLV</b>	<b>threshold limit value</b>
<b>TWA</b>	<b>time weighted average</b>
<b>STEL</b>	<b>Short-term Exposure Limit</b>



**BERYLLIUM**  
**CAS NO. 7440-41-7**

**Synonyms:**

metallic beryllium	Beryllium dust
Beryllium-9	Beryllium, metal powder
Glucinium	
Glucinum	

**Chemistry and Uses:**

**Description:** Beryllium is a hard, grayish-white metal. It is insoluble in cold water and soluble in diluted acids and alkalies.

**Uses:** Beryllium occurs as a chemical component of certain rocks, soil, and volcanic dust. Alloys of beryllium are used in making electronic parts, construction materials for machinery, nuclear weapons, aircraft, x-rays, etc. (ASTDR, 1992).

**Fate:**

**Releases to the environment:** Beryllium is emitted naturally by dusts and volcanic particles (EPA 1987). A major emission source of beryllium is the combustion of coal and fuel oil. Exposure to beryllium is through inhalation and ingestion of food and water (ASTDR, 1992).

In most soil, beryllium is expected to tightly absorb, especially to clay surfaces at low pHs. Therefore, beryllium is expected to have a low mobility in soil. It is not likely to leach through soil (ASTDR, 1992).

Beryllium has low mobility in water due to its absorption to sediment.

Residence time for beryllium in ocean water is about a few hundred years. Beryllium is extremely toxic to warm-water fish in softwater. Bioconcentration is not likely by aquatic organisms.

Transport of beryllium occurs through wet and dry deposition. Dry deposition rate of aerosol particles is a function of particle size, windspeed, and surface roughness.

**Human Health Effects:**

Routes of exposure to beryllium occur through inhalation of dust and ingestion of contaminated food or water.

Chronic exposure to beryllium causes shortness of breath, scarring of the lungs and benign growths in the lungs. Acute exposure causes dermatitis, corneal conjunctivitis, etc. (NLM, 1992).

Systemic effects in rats over a duration of 1 hour resulted in a low observed adverse effect level (LOAEL) of 0.447 mg Be/m<sup>3</sup>, and a no observed adverse effect level (NOAEL) of 31 mg Be/m<sup>3</sup> over a 10 day exposure period (ASTDR, 1992).

Beryllium is highly toxic, especially by inhalation of dust. It has a threshold limit value of 0.002 mg/m<sup>3</sup> (Sax, 1987).

Environmental Effects:

A measured bioconcentration factor (BCF) of 19 was reported for bluegill fish. The TLm for the fathead minnow was 150 µg/L/96 hr in soft water.

**BARIUM**  
**CAS NO. 7440-39-3**

**Synonyms:**

Bario (Spanish)  
Baryum (French)  
Elemental Barium

**Chemistry and Uses:**

**Description:** A silvery-white, malleable metal that is easily oxidized. Barium occurs in nature as many different compounds. It is highly flammable at room temperature in powder form. Barium reacts readily with water, ammonia, oxygen, and most acids (ASTDR, 1991).

**Uses:** Barium is produced by reducing barium oxide with a less reactive, non-volatile element. It is used as a carrier for radium, a deoxidizer of copper, spark-plug alloys, and getter alloys in vacuum tubes (HSDB, 1991).

**Fate:**

**Releases to the atmosphere:** Barium is a highly reactive metal that occurs naturally in a combined state. It is released by both natural processes and anthropogenic sources. It is primarily released by industrial means during mining, refining, etc., and the combustion of coal (ASTDR, 1991).

Barium is not very mobile in most soil systems. This is dependent on the characteristics of the soil. If not taken up by vegetation, barium will be transported through the soil by precipitation (ASTDR, 1991).

Barium may leach into groundwater (in the presence of chloride) and adsorb to soils and sediments (ASTDR, 1991).

Barium is not expected to hydrolyze except in highly alkaline environments. It is likely to precipitate out as an insoluble salt. Barium may adsorb to suspended particulate matter. The uptake by fish and marine organisms is also an important removal process (ASTDR, 1991).

Barium is primarily removed from the air by wet and dry deposition. It is easily and readily oxidized in moist air. Residence time in air is dependent on size, chemical structure, and environmental factors (ASTDR, 1991).

### Human Health Effects:

Exposure to barium occurs by ingestion or inhalation of dust or fume and by skin and eye contact (NLM, 1991).

Barium is not considered to be an industrial health hazard. Exposure to barium resulted in increased blood pressure. No data were available for human LOAELS. A NOAEL of 0.21 mg/kg/day has been established. Hypertension, stroke, heart and renal disease were noted after exposure (ASTDR, 1991).

### Environmental Effects:

The uptake of barium by fish and marine organisms is an important removal mechanism. Barium was found to bioconcentrate in marine plants by a factor of 1,000 times the level present in water. Bioconcentration factors (BCFs) in marine animals, plankton, and in algae of 100, 120 and 260, respectively, have been reported (ASTDR, 1991).



CADMIUM  
CAS NO. 7440-43-9

Synonyms:

Kadmium (German)  
CI 77180  
Colloidal Cadmium

Chemistry and Uses:

Description: Cadmium is a soft, ductile, silver-metal, which has an atomic weight of 112.40 and a specific gravity of 8.642. It is found in many soil profiles under natural conditions. It is readily attacked by most acids and occurs naturally as zero valence (metal and alloys) and the +2 valence (compounds) [U.S. EPA, 1980].

Uses: Commercial uses include electroplating and engraving, as a constituent of easily fusible alloys, of soft solder and of solder for aluminum, in the manufacture of cadmium-vapor lamps, photoelectric cells, Ni-Cd batteries, and as an amalgam in dentistry (Merck & Co., 1968). In the atmosphere, cadmium is expected to be present as dust and fumes from smelting of ores, manufacturing of metallic-alloys, reprocessing of cadmium-containing alloys, recycling of scrap steel, emissions of coal-fired power plants, and incineration of solid wastes (NLM, 1989).

Fate:

The principal removal mechanisms for atmospheric cadmium are wet and dry deposition. The predominant fate of cadmium in aquatic media is sedimentation through binding onto clays or organic matter, and precipitation with manganese oxide, iron oxide, and hydrates (NLM, 1989). Cadmium is also bound onto soil particles with increased binding as the organic matter content of soil increases. Transport in soils may be in the form of nitrate, chloride, carbonate complexes, hydroxide complexes, ammonia complexes, and as chelated and other organo-metallic complexes resulting from organic decay. In the aquatic environment, cadmium is relatively mobile and may be transported in solution as either hydrated cations or as organic or inorganic complexes. Photolysis is not an important removal process (NLM, 1989).

Human Health Effects:

Several studies indicate that cadmium is poorly absorbed by the gut. In Japan, however, chronic exposure through cadmium-contaminated food items caused what is known as itai-itai disease. This disease was caused by cadmium's ability to weaken bone structure. A lowest observable effect level dose is estimated to be 301  $\mu\text{g/kg-bw/day}$ . Cadmium is absorbed more efficiently by the lungs than by the gut in humans. Respiratory problems and possible renal complications are associated with chronic occupational exposure to cadmium fumes. A major non-occupational source of respirable cadmium is cigarettes. The estimated intake from the source is 0.1 to 0.2 micrograms per cigarette. Inhalation of welding fumes from metals containing cadmium may result in "metal fume fever" and acute reaction to occupational levels of cadmium (NLM, 1989).

Cadmium also has long-term toxicity to mammals. It is particularly effective because it is not eliminated by the organism and accumulates mostly in the bones. There is also evidence of a correlation between cadmium poisoning and arterial hypertension. Cadmium has been demonstrated to be teratogenic and to reduce fertility following intravenous, intraperitoneal, and subcutaneous administration. It appears that cadmium can be mutagenic under some conditions; however, the relationship between mutagenicity and carcinogenicity is not as well correlated for metals as for some other classes of carcinogens. Cadmium has been classified by the U.S. EPA. Carcinogen Assessment Group as a probable human carcinogen by inhalation based upon limited human exposure data. Insufficient data exist to classify cadmium as carcinogenic to humans by the oral route (NLM, 1989).

#### Environmental Effects:

Acute toxicity of cadmium ranged from 33-63  $\mu\text{g/L}$  for *Daphnia magna*, 8-12,000  $\mu\text{g/L}$  for fathead minnows, and 21,000  $\mu\text{g/L}$  for bluegill (U.S. EPA, 1980a; Birge et al., 1985). Birge and others. (1985) also reported concentrations of 140 ad 240  $\mu\text{g/L}$  for carp and bass, respectively, in a 96-hour  $\text{LC}_{50}$  test.

**CHROMIUM**  
**CAS NO. 7440-47-5**

**Synonyms:**

Chrome  
Chrom (German)  
Chrome (French)

**Chemistry and Uses:**

**Description:** Chromium is a naturally occurring element. It is a steel-gray lustrous metal with a high melting point, that occurs in several different forms. No known taste or odor is associated with chromium. Toxicological important routes of entry are inhalation and ingestion.

**Uses:** Chromium is used in coloring glass and as pigment for floor coverings, paper, cement and asphalt roofing. It is also used as a component in stainless and heat-resisting steels. Air emissions containing chromium result from paper mills, petro-chemical fertilizers, metal foundries and steam-generation power plants (NRCC, 1976.) The sources of chromium in wastewater are from its use as a corrosion inhibitor and from dyeing and tanning industries (Brown, 1983).

**Fate:**

Chromium is very mobile in groundwater and sometimes used as a tracer to follow groundwater flows. In the atmosphere, chromium is associated with particulate matter and is not expected to exist in a gaseous form. Large particles will deposit quickly. Small particles form stable aerosols and may be transported many miles. Hexavalent chromium does not absorb to clay. Sandy soils with low organic contents have high chromium (III) availability (NRCC, 1976).

**Human Health Effects:**

Chromium compounds act as allergens, which cause dermatitis to exposed skin. Exposures to dust or mist may cause coughing, wheezing, and headaches. Chromium may have a corrosive effect on the mucous membranes of the upper respiratory tract. When compared to adult tissues, human fetus (heart, liver and spleen) showed an accumulation factor of 10. The level decreased upon aging (NRCC, 1976).

**Environmental Effects:**

The bioconcentration factor for chromium in rainbow trout is approximately 1. In bottom feeder bivalves such as the oyster, mussel, and soft shell clam, the BCF may range from 86 to 192. Chromium is not expected to biomagnify in the aquatic food chain.

LEAD  
CAS NO. 7439-92-1

Synonyms:

Pb  
Plumbum

Chemistry and Uses:

**Description:** Lead is a heavy, ductile, soft gray metal. It is a known carcinogen of the lungs and kidneys.

**Uses:** Lead is the fifth most important metal commercially in the United States and enters the environment through mining, processing, smelting, refining, recycling, or disposal. Lead is utilized in the metallurgy process and can be added to other alloys to improve their characteristics. It is a common constituent of pigments for paints, varnishes, storage batteries, rubber, plastics, and electronic devices.

Fate:

Lead is an extremely stable metal, although it dissolves in acid. Lead usually converts to more insoluble forms in soil, although some corrosion may be expected. It also forms complexes with organic matter and clay minerals, which limit its mobility. In water, lead sinks into the sediment, although when dissolved it will form ligands that vary with pH. Lead will also form compounds of low solubility with the major anions of natural water. Biomethylation of lead by benthic microorganisms can lead to its remobilization and reintroduction into the aqueous environment.

Human Health Effects:

Lead is poisonous in all forms. Systemic lead poisoning can result from inhalation of airborne lead particulate matter or fumes, or from ingestion in its ionic form in water and food. Ingestion of metallic lead can lead to an acute attack after a long asymptomatic period. Lead ingestion may result in an astringent and metallic taste in the mouth, dry throat, thirst, burning abdominal pain, and vomiting, occasionally accompanied by diarrhea or constipation. Stools may be bloody or black due to the presence of lead sulfide. Other symptoms include peripheral circulatory collapse and neuromuscular symptoms, such as muscular weakness, pain and cramps, especially in the legs. Central nervous system manifestations include headaches, insomnia, paresthesia, depression, comas, and death. Exposure to lead by children occasionally produces progressive mental deterioration.

### Environmental Effects

Lead does not appear to bioconcentrate significantly in fish, but does in some shellfish such as mussels. The log BCF on a wet weight basis in freshwater fish ranges from 1.38 to 1.65; for freshwater invertebrates the range is 2.70 to 3.23.

NICKEL  
CAS NO. 7440-02-0

Synonyms:

Ni

Elemental Nickel

Synonyms of other compounds vary depending upon the specific nickel component.

Chemistry and Uses:

Description: Nickel is a hard, ductile, magnetic metal with a silver-white color. It is classified as a flammable solid.

Uses: Nickel is a valuable mineral commodity because of its resistance to corrosion. It is used extensively in the production of stainless steel. Other uses include electroplating baths, batteries, and textile dyes. In the atmosphere, nickel is present as suspended particulate matter.

Fate:

Nickel is continuously transferred between environmental sectors by erosion, precipitation, and weathering. Various dry and wet precipitation processes remove particulate matter as washout or fallout from the atmosphere to soils and water systems. The transportation of nickel in soils is dependent upon physical and chemical interactions. Aquatic nickel mobility is controlled mainly by the capability of various sorbents to release it from solution. Although nickel is bioaccumulated, the concentration factors suggest that partitioning is not a dominant fate process. No data were found to suggest that nickel is involved in any biological transformation in the aquatic environment.

Human Health Effects:

Routes of intake for humans are inhalation, ingestion, and percutaneous absorption. Skin sensitization is the most common toxic reaction. Pulmonary absorption varies according to the physical form of the compound. Target organs during inhalation exposures have been identified as the lung, brain, kidney, and liver. Based on animal studies, nickel appears to have a very short half-life of several days. There is evidence, both in humans and animals, of carcinogenic effects from nickel exposures.

### Environmental Effects:

Six strains of algae were tested for their ability to bioaccumulate. The concentration factor for nickel was determined in the range of  $0 - 3.0 \times 10^3$ . The effect of environmental bioaccumulation has been observed to depend on pH. Most of the algae strains accumulated nickel optimally at a pH of 8.0 (Env. Sci. Tech., 1984). Although aquatic organisms may accumulate nickel from their surrounding, there is little evidence for significant biomagnification with food chains (NRCC, 1981). The NOAEL and LOAEL values have been published at 5 and 50 mg/kg/day, respectively (Ambrose et al., 1976).

**DI-N-BUTYLPHTHALATE**  
**CAS NO. 84-74-2**

**Synonyms:**

o-Benzenedicarboxylic Acid  
Dibutyl Ester  
n-Butyl Phthalate  
Celluflex DPB  
DBP  
Dibutyl 1,2-Benzenedicarboxylate  
Elaol  
Hexaplas M/B  
NA 9095  
Palatinol C  
Polycizer DBP  
PX 104  
Staflax DBP  
Witcizer 300

**Chemistry and Uses:**

**Description:** Di-n-butyl phthalate is a colorless to faint yellow viscous liquid, with a slight, but characteristic ester odor.

**Uses:** Di-n-butyl phthalate is used primarily to soften plastics such as raincoats, car interiors, vinyl fabrics, and floor tiles. It is also used in nail polish, aftershave lotion, adhesives, and caulking (NLM, 1990).

**Fate:**

Di-n-butyl phthalate exists primarily as particulate matter and is subject to gravitational settling when released into the atmosphere. It has an estimated half-life of 18 hours in air, and the free molecule will photodegrade by reaction with hydroxyl radicals. In water, di-n-butylphthalate will adsorb moderately to sediment and complex with humic material in the water column. Biodegradation rates are rapid with 90-100percent degradation in 3-5 days in industrial rivers, and 2-17 days in water from a variety of estuarine and freshwater conditions. Although it biodegrades under anaerobic conditions, its fate in groundwater remains unknown. Di-n-butyl phthalate will adsorb to a moderate extent and will slowly biodegrade in soil (66 to 98percent degradation in 26 weeks from two soil) (NLM, 1990).



### Human Health Effects

Exposure to di-n-butyl phthalate may occur through inhalation, ingestion, or dermal routes. It can be found in wastewater emissions during production and use, incineration of plastics, and migration from products from which it is constructed. Exposure may also occur from drinking water and food products. Contact may cause burns to skin and eyes. Breathing plasticizers as sprays can cause throat irritation. Problems with menstrual disorders and higher rates of miscarriages, reduced gestation, and delivery rates have been reported among women who worked in industries where phthalates were used. Di-n-butyl phthalate has not been classified as a carcinogen as both human and animal studies are not available (U.S. EPA, 1990).

### Environmental Effects

Di-n-butyl phthalate is readily metabolized and does not bioaccumulate in fish to any extent. Studies of clams (Neanthes virens), american oysters, brown shrimp, and sheepshead minnow reported similar findings. Di-n-butyl phthalate is toxic to synchronously developing larvae of the brine shrimp, Artemia. An  $LC_{50}$  value of 0.21 mg/L/1500 hr were found in scud (Gammarus fasciatus), while the alga, Gymnodinium breve, was reported to have a  $LC_{50}$  value of 0.02-0.6 ppm/96 hr (NLM, 1991).

**NAPHTHALENE**  
**CAS NO. 91-20-3**

**Synonyms:**

Camphor Tar  
Mighty 150  
Mighty RD1  
Moth Balls  
Moth Flakes  
Naphthalin  
Naphthaline  
Naphthene  
NCI-C52904  
VR 1334  
VR 2304  
White Tar

**Chemistry and Uses:**

**Description:** Naphthalene is a white, solid substance with the characteristic odor of tar or mothballs (ATSDR, 1990).

**Uses:** Naphthalene is used primarily in the manufacture of dyes and resins. In addition, naphthalene is a major component in mothball production.

**Fate:**

Naphthalene enters the atmosphere primarily from fugitive emissions and exhaust associated with its presence in fuel oil, coal tar, and gasoline. Naphthalene readily volatilizes in the atmosphere with a half-life of 3-8 hours. Releases into the water are lost to volatilization, photolysis, adsorption, and biodegradation. Half-lives vary by process, but can be expected to range from a few days to a few months. Naphthalene is adsorbed moderately in soil and undergoes biodegradation. In some cases, it will appear in groundwater where biodegradation may still occur (NLM, 1990).

**Human Health Effects:**

Surface contact with naphthalene can cause cataracts and ocular irritation, skin irritation, and in sensitized individuals, severe dermatitis. When inhaled, headache, confusion, and excitement may result. Ingestion of naphthalene may produce abdominal cramps with nausea, vomiting, and diarrhea, also headache, profuse perspiration, listlessness, and confusion. In severe poisoning, coma with or without convulsions may occur. Acute hemolysis accompanied after 3 days by anemia, leukocytosis, fever, hemoglobinuria, jaundice, renal insufficiency, and sometimes disturbances of liver function is the most characteristic symptom. In the absence of supportive treatment, death may result from acute renal failure in adults or kernicterus in infants (NLM, 1990).

### Environmental Effects

Bioconcentration is known to occur to a moderate extent in fish and invertebrates, but since depuration and metabolism proceed quickly in aquatic systems, it is not considered to be a significant problem. Log octanol/water partition coefficients ranged from 3.29 to 3.37 (ASTDR, 1990). Naphthalene has a log bioconcentration factor of 1.6-3.0 for fish and aquatic invertebrates.

**CARBON TETRACHLORIDE**  
**CAS NO. 56-23-5**

**Synonyms:**

Benzinoform  
Carbona  
Carbon TET  
Methane Tetrachloride  
Perchloromethane  
VR 1846  
Tetrasol

**Chemistry and Uses:**

**Description:** Carbon tetrachloride is a colorless liquid with a characteristics ether-like odor. It is miscible with alcohol, benzene, chloroform, and ether. High vapor pressure (91.3 mm Hg at 20°C) suggests rapid evaporation.

**Uses:** Carbon tetrachloride is used as a solvent for oils, lacquers, varnishes, and resins. It is also used as a drying agent for spark plugs.

**Fate:**

Carbon tetrachloride has been noted to be slightly removed during infiltration of river water into adjacent monitoring wells. In addition to its high vapor pressure, the soils' low adsorption coefficient contributes to groundwater migration. Evaporation from water is a significant removal process. Based upon field-monitoring data, the estimated half-life in groundwater and lakes is 3-300 days.

Carbon tetrachloride is very stable in the atmosphere with residence times of 30-50 years (NLM, 1991). Its main atmospheric loss is photolytic diffusion. It is estimated that less than 1percent of carbon tetrachloride released to the air is partitioned into the oceans (NLM, 1991). Hydrolysis half-life in water is 7,000 years at 25°C (NLM, 1991). Bioconcentration factors in aquatic organisms and sediment adsorption is not significant.

**Human Health Effects**

Routes of entry for human exposures to carbon tetrachloride are skin contact, ingestion, and inhalation. Repeated contact may lead to fissured dermatitis. Excessive exposure may result in depression of the central nervous system. Acute episodes can develop into liver and kidney disorders. Other symptoms include nausea, abdominal pain, and toxic hepatitis. Carbon tetrachloride is classified as a human carcinogen (NIOSH, 1987).

### Environmental Effects

A 96-hour  $LC_{50}$  for bluegills was reported at 125,000  $\mu\text{g/L}$ . A  $LC_{50}$  of 67 ppm was identified for Poecilia reticulata (guppy) during a 14 day bioassay. Rainbow trout were exposed to 10, 40, 60, and 80 mg/kg of carbon tetrachloride in water for 2, 4, 6, and 8 hours. After the exposure episodes, the highest concentration was detected in the fat. Lower levels were present in liver, heart, and gills.

MERCURY  
CAS NO. 7439-97-6

Synonyms

Hg  
Colloidal Mercury  
Metallic Mercury  
Quicksilver

Chemistry and Uses:

Description: Mercury is a silver-white, heavy, odorless liquid metal. It is insoluble and classified as non-combustible liquid.

Uses: Mercury ore is ubiquitous in rock formations and is also present under natural conditions in soils. Besides a variety of inorganic compounds, mercury forms a number of organic chemicals. Organic compounds are toxicologically and environmentally significant because they can be rapidly absorbed by living organisms. Mercury is used in a number of industrial processes and in fungicides. The largest industrial use of mercury is for the manufacture of electrical apparatus. Mercury in ambient air is largely derived from electrical and chloroalkali industries and the burning of fossil fuels.

Fate:

Mercury binds strongly to soils, especially to soil organic material. Elemental mercury is very immobile in soil; thus, leaching to groundwater is unlikely. Organomercury develops in soil within 30 to 50 days after application in the presence of biological activity. Availability of soil mercury to plants is very low and there is a root barrier to translocation of mercury to plant tops. Volatility of elemental mercury accounts for high atmospheric concentrations, reported at 20 to 200  $\mu\text{g}/\text{m}^3$  near areas containing high soil levels of 10 mg/kg (normal atmospheric concentration = 5  $\mu\text{g}/\text{m}^3$ ). Mercury binds to atmospheric dust particles which are removed by wet and dry deposition. Photodegradation may be important in the removal of vapor-phase mercurial compounds (NLM, 1989).

In aquatic systems, mercury appears to bind to dissolved matter or fine particulates and to bed sediments. Mercury in sediments can be desorbed into the water column, transported, and redeposited. Methylation is likely to occur in the top two centimeters of the sediments. Virtually any mercurial compound can be microbially converted to methyl mercury. Methylation is also reported to occur among zooplankton. Transformation to volatile chemicals, such as dimethyl mercury may result in loss to the atmosphere or conversion to photolysis to methylmercury and return to the surface water. Mercury bioaccumulates and concentrates in the food chain, where it then acts as a significant transport mechanism (NLM, 1989).

### Human Health Effects:

Metallic mercury is poorly absorbed from the gastrointestinal tract. However, ingested organic mercury, especially methylmercury, is almost completely absorbed. The respiratory system is much more efficient in absorbing mercury vapor. Studies indicate that approximately 80 percent of the inhaled vapor is absorbed. Data regarding the absorption of organic mercury via the lungs have not been identified in the literature reviewed.

The toxic effects of chronic exposure to elevated levels of mercury have been well documented. Exposure to elevated organic mercury resulted in Japan after consumption of tainted seafood and in Iraq after people consumed bread made from grain treated with a mercury-containing fungicide. The major signs of toxicity were twitching in the extremities, impaired peripheral field of vision, slurred speech, and unsteadiness of gait and limb. Maximum severity of symptoms occurred several weeks after the end of exposure.

The Human Health Assessment Group of the U.S. Environmental Protection Agency has classified this chemical as "not classifiable as to human carcinogenicity." No human datum is available, and animal and supporting data are inadequate to classify possible human effects (U.S. EPA, 1989).

### Environmental Effects:

The U.S. EPA Ambient Water Quality Criteria document reports acute 96-hour  $LC_{50}$  values of 5, 15 and 24-400  $\mu\text{g/L}$  for Daphnia, fathead minnows, and trout, respectively. A value of 350  $\mu\text{g/L}$  has been reported for catfish (NLM, 1989). MATC values in the ranges of 1 - 2.47  $\mu\text{g/L}$ , for Daphnia have been reported. Barnhouse and Suter (1986) reported a NOEC of  $<0.23$  -  $<0.26$   $\mu\text{g/L}$  for fathead minnows and Beryl et al. (1985) reported a MATC of 0.29 - 0.93  $\mu\text{g/L}$  for trout.

**1,1-DICHLOROETHANE**  
**CAS NO. 75-34-3**

**Synonyms:**

Chlorinated Hydrochloric Ether  
1,1-Dichloroethan  
Ethylidene Chloride  
Ethylidene Dichloride  
NCI - C04535  
VR 2362

**Chemistry and Uses:**

**Description:** 1,1-Dichloroethane is a colorless, oily liquid with an aromatic ethereal odor and saccharine taste.

**Uses:** 1,1-Dichloroethane is produced commercially from hydrogen chloride and vinyl chloride. It is used as an extractant for heat-sensitive substances and in the manufacture of high vacuum rubber.

**Fate:**

1,1-Dichloroethane is released into the environment as fugitive air emissions and in wastewater resulting from its production and use as a chemical intermediate. 1,1-Dichloroethane is mobile in the environment, with a moderate water solubility (5,500 mg/L), high vapor pressure (230 mm Hg at 25°C), and low organic carbon partition coefficient (43). It has a log octanol water partition coefficient of 1.9. When 1,1-dichloroethane is released to the soil it will be lost rapidly through evaporation. There is a possibility for leaching into the groundwater due to its low soil adsorptivity. 1,1-Dichloroethane released to surface water will also be lost primarily through volatilization, with half-lives of 6-9 days for ponds, 5-8 days for lakes, and 24-32 hours for rivers. Adsorption to sediment, biodegradation, and hydrolysis should be insignificant. When released into the atmosphere, 1,1-dichloroethane degrades by reaction with photochemically produced hydroxyl radicals, with a half-life of 62 days. 1,1-Dichloroethane will dispose considerably in the atmosphere and will be washed out by rain due to its moderate solubility in water (NLM, 1989).

**Human Health Effects:**

1,1-Dichloroethane can be absorbed into the human body by inhalation, ingestion, and skin or eye contact. It produces central nervous system depression, respiratory tract irritation, and skin burns. The impact of 1,1-dichloroethane on human organs has not yet been defined, with one study showing the chemical to cause liver and kidney damage, and other studies showing relatively low capacity to cause liver or kidney injury even on repeated exposure. 1,1-Dichloroethane is about one-half as toxic as 1,2-dichloroethane. It is an experimental teratogen and tumorigen, but has not been shown to be mutagenic. 1,1-Dichloroethane has been classified by U.S. EPA as a possible human carcinogen based on limited evidence in animals (U.S. EPA,



1990). Recent chronic studies indicate that 1,1-DCA has little capacity for causing liver damage. Rats, guinea pigs, rabbits, and dogs were exposed to either 500 or 1000 ppm for 7 hr/day, 5 days/week for 6 months. Pathological studies showed no evidence of changes due to the exposure (ACGIH, 1986). An oral study reported a  $LD_{50}$  for rats of 14.1 g/kg (Encyc. Chem. Tech, 1978). During a mouse and rat inhalation study,  $LC_{50}$ s of 17, 300 ppm/2 hour and 16,000 ppm/8 hour were reported, respectively (Verschuere, 1983).

#### Environmental Effects

A 96-hour static bioassay in freshwater resulted in a  $LC_{50}$  of 550 ppm for bluegill (Verschuere, 1983). During a 7-day bioassay, guppies were reported to have a  $LC_{50}$  of 202 ppm (Verschuere, 1983). The estimated concentration factor for 1,1-dichloroethane is 1.3, indicating insignificant bioconcentration in fish. The Koc estimated from water solubility is 4.3. This value indicates little potential for absorption to soil organic matter. 1,1-DCA has been noted to be readily leached from materials at land disposal sites (Verschuere, 1983). All of the chloroethanes have a whole body elimination half-life in exposed bluegills of less than two days (NLM, 1989).

**METHYLENE CHLORIDE**  
**CAS NO. 75-09-2**

**Synonyms:**

Dichloromethane  
Aerotherne MM  
Chlosure de Methylene  
DCM  
Methane Dichloride  
Methylene Bichloride  
Narkotil  
NCI-C50102  
VR 1593  
Solaeathin  
Solmethine

**Chemistry and Uses:**

**Description:** Methylene chloride is a colorless liquid with a sweet, chloroform-like odor. Due to its high vapor pressure (400 mg Hg at 24.1°C), methylene chloride is expected to volatilize readily.

**Uses:** Methylene chloride is used as a paint remover, degreaser, and low temperature extractant of substances which are adversely affected by high temperature. In the chemical processing industry, methylene chloride is also used as a carrier solvent for insecticides and herbicides.

**Fate:**

When methylene chloride is spilled onto the land it will primarily evaporate due to its high vapor pressure. Some methylene chloride is assumed to leach through the soil into the groundwater, although data on adsorptivity are lacking. Methylene chloride released to surface water will be lost by evaporation, taking several hours depending on wind and mixing conditions. Biodegradation is possible in surface waters, but will probably be slow compared to evaporation. Hydrolysis is not an important degradation process with a minimum half-life of 18 months. Degradation in groundwater is unknown. Methylene chloride released to the atmosphere will degrade by reaction with hydroxyl radicals, with a half-life of several months. A small fraction of the chemical will diffuse to the stratosphere where it will degrade rapidly by photolysis and reaction with chlorine radicals. Methylene chloride is partially returned to earth through precipitation (NLM, 1989).

### Human Health Effects:

Methylene chloride is a mild narcotic. Effects of intoxication include headaches, irritability, numbness, and tingling in the limbs. The liquid and vapors are irritating to the eyes and upper respiratory tract at higher concentrations. The primary route of human exposure is through inhalation. Once inside the body, methylene chloride is absorbed through the body membranes and rapidly enters the bloodstream (ATSDR, 1989). If the liquid is held in contact with the skin, severe burns may develop. In severe cases of overexposure, observers have noted toxic encephalopathy with hallucinations, pulmonary edema, coma, and death. Cardiac arrhythmias have been produced in animals, but have not been common in human experiences. Methylene chloride is classified as a probable human carcinogen (NLM, 1990). LD<sub>50</sub> for a rat (oral bioassay) was reported at greater than 1600 mg/kg (Verschueren, 1983). LD<sub>50</sub> for a mouse (inhalation bioassay) was listed as greater than 16,000 ppm/7hr (IARC, 1986). LC<sub>50</sub> for a guinea pig during an inhalation bioassay was reported at greater than 11,600 ppm/6hr (IARC., 1986).

### Environmental Effects:

The 96-hour LC<sub>50</sub> for the fathead minnow was 193 mg/L in a flow-through test and 310 mg/L in a static test. The LC<sub>50</sub> for the bluegill was 230 mg/L and 220 mg/L for 24- and 96-hour tests, respectively (conditions unspecified). The LC<sub>50</sub> for the guppy in a 14-day test was 294 ppm and 224 mg/L for Daphnia magna in a 48-hour test. Although experimental data are lacking, methylene chloride is not expected to bioconcentrate due to its low octanol/water partition coefficient, log Kow equals 1.25 (NLM, 1989). The NOAEL for males and females are 5.85 mg/kg/day and 6.47mg/kg/day, respectively (National Coffee Association, 1982). The LOAEL for males and females were reported as 52.58 mg/kg/day and 58.32 mg/kg/day, respectively (National Coffee Association, 1982).

**BIS (2-ETHYLHEXYL) PHTHALATE**  
**CAS NO. 117-81-7**

**Synonyms:**

**BEHP**  
**1,2-Benzenedicarboxylic Acid**  
**Bisoflex 81**  
**Bisoflex DOP**  
**DEHP**  
**Di-sec-Octyl Phthalate**  
**Ergoplast FDO**  
**Eviplast 80**  
**Eviplast 81**  
**Fleximel**  
**Flexol DOP**  
**Hatcol DOP**  
**Hercoflex 260**  
**Mollan O**  
**NCI-C52733**  
**Sicol 150**  
**Vinicizer 80**  
**Witcizer 312**

**Chemistry and Uses:**

**Description:** Bis (2-ethylhexyl) phthalate is a colorless to light colored oil with a slight odor. It has a low vapor pressure (1.32 mm Hg at 200°C).

**Uses:** Bis (2-ethylhexyl) phthalate is commonly used as a plasticizer for PVC resins. Other uses include pesticide formulations, dielectric fluids, and solvents. Although there have been reports suggesting natural sources of the chemical, they are negligible compared to manmade sources (ATSDR, 1989).

### Fate:

Bis (2-ethylhexyl)phthalate has a strong tendency to adsorb to soil and sediment, particularly organic-rich soils. Due to its low volatility, bis (2-ethylhexyl) phthalate will tend not to evaporate when discharged to the land or water. DEHP has been shown to biodegrade under aerobic conditions, with a half-life of several days. Biodegradation under anaerobic conditions occurs very slowly, if at all. Evaporation of DEHP from surface waters is likely to be negligible, with sediments playing a more important role in determining the fate of the chemical. Because of its low vapor pressure and strong adsorptive tendency, atmospheric DEHP will have a strong tendency to adsorb to atmospheric particulates and be removed in precipitation (ATSDR, 1989).

### Human Health Effects:

Bis (2-ethylhexyl) phthalate is absorbed well through the gastrointestinal tract following ingestion. Once absorbed, DEHP is distributed through the body with the liver and testes being main target organs. Elimination from the body is rapid, with only a slight cumulative potential.

### Environmental Effects:

Reported LC<sub>50</sub> values for the coho salmon, channel catfish, rainbow trout and bluegill were greater than 100 mg/L for a 96-hour static test. Other tests reported LC<sub>50</sub>s of greater than 770 mg/L for bluegills in a 96-hour test and 1,000-5,000 µg/l for Daphnia magna in a 48-hour test. Bis (2-ethylhexyl) phthalate does have a tendency to bioconcentrate in aquatic organisms. Experimental log bioconcentration factors range from two to four in fish and invertebrates. The bioconcentration factor for rainbow trout ranged from 42 to 113 for a 36-day test. Fathead minnows had a bioconcentration factor of 115-886 in a 56 day test. The log octanol/water partition coefficient for bis (2-ethylhexyl) phthalate is 4.88 (NLM, 1989).

DEHP has a strong tendency to adsorb to soil and sediments. Calculated log K<sub>oc</sub> values of 4-5 have been reported. Evidence demonstrates strong partitioning to clays and sediments. DEHP has a very low vapor pressure and Henry's Law Constant  $1 \times 10^{-4}$ . This value relates to a low potential of evaporation from soils or water.

1,2-DICHLOROETHENE  
CAS NO. 540-59-0

Synonyms:

Acetylene Dichloride  
1,2-Dichloroethylene  
Diaform  
NCI-C56031

Chemistry and Uses:

Description: 1,2-Dichloroethene is a colorless, flammable liquid with a slightly acrid, chloroform-like odor. It can be present in two isomers, trans and cis.

Uses: 1,1-Dichloroethene is most often used in the production of solvents and in chemical mixtures. It is also a by-product in the manufacture of chlorinated compounds.

Fate:

1,2-Dichloroethane released to the soil will evaporate readily, or leach into the soil, where it will biodegrade very slowly. When released to the water, it will be lost mainly through volatilization, with a half-life of 3 hours in a model river. Biodegradation and adsorption of 1,2-dichloroethene to sediment should not be significant. In the atmosphere, 1,2-dichloroethene will degrade by reaction with photochemically produced hydroxyl radicals, with half-lives of 8 and 3.6 days for the cis and trans isomers, respectively (NLM, 1989).

Human Health Effects:

Exposure to 1,2-dichloroethene vapors can cause nausea, vomiting, weakness, tremor, epigastric cramps, and central nervous system depression. Exposure to the eye may result in reversible corneal clouding. 1,2-Dichloroethene is considered toxic by inhalation, skin contact, or ingestion. The chemical is largely excreted through the lungs (NLM, 1989). It has not been evaluated by EPA for human carcinogenicity (U.S. EPA, 1990).

Environmental Effects:

The recommended octanol/water partition coefficients for cis- and trans-1,2-dichloroethene are 1.86 and 2.06, respectively. One can estimate a bioconcentration factor of between 15 and 22, indicating that 1,2-dichloroethene will not bioconcentrate significantly in aquatic organisms (NLM, 1989).

**TRICHLOROETHYLENE**  
**CAS NO. 79-01-6**

**Synonyms:**

Acetylene Trichloride  
Algylen  
Anamenth  
Benzinol  
Cecolene  
Dow-Tri  
Ethinyl Trichloride  
Ethylene Trichloride  
Fluate  
TCE  
Tri-clene  
VR 1710  
Vestrol  
Westrasol

**Chemistry and Uses:**

**Description:** Trichloroethene (TCE) is a clear, colorless liquid with a sweet odor. The odor is detectable at a level of 50 ppm. TCE is soluble in chloroform acetone, alcohol, and ether. Its solubility in water is 1.110 mg/L at 25°C. The vapor pressure is 19.9 mm Hg at 0°C.

**Uses:** TCE is used for vapor degreasing of metals. It is also used as a chemical intermediate in the production of pesticides, waxes, gums, resins, tars, and paints. It is now known to occur as a natural product.

**Fate:**

TCE enters the atmosphere as air emissions from metal degreasing plants and as wastewater from metal finishing, paint and ink formulation, electrical/electronic components, and rubber processing industries (NLM, 1989). When released to the land, TCE evaporates readily due to its high vapor pressure. It may also leach through the soil and into the groundwater, where it may remain for a long time. There is some evidence of degradation in the soil to form other chlorinated alkenes. The aquatic fate of TCE is low by evaporation with a half-life ranging from minutes to hours, depending upon the turbulence of the water. Biodegradation, hydrolysis, and photo-oxidation will occur at a much slower rate. In the atmosphere, TCE will react fairly rapidly, especially under smog conditions. An atmosphere residence time of 5 days has been reported with the formation of phosgene, dichloroacetyl chloride, and formyl chloride (NLM, 1989).

### Human Health Effects:

Exposure to trichloroethylene vapor may cause irritation of the eyes, nose, and throat. Repeated or prolonged skin contact with the liquid may cause dermatitis. Acute exposure to TCE depresses the central nervous system exhibiting such symptoms as headaches, dizziness, vertigo, tremors, nausea, blurred vision, and irregular heart beat. If splashed in the eyes, the liquid may cause burning irritation and severe damage. Prolonged occupational exposures to TCE have been associated with impairment of peripheral nervous system function. Alcohol may make symptoms of overexposure worse. The LD<sub>50</sub> for humans is 50 to 500 mg/kg (NLM, 1989). TCE is recognized as a probable human carcinogen. The aggregate risk of cancer due to exposure to TCE is 4.1 cases per year for persons living within 50 km of emission sources (51 Federal Register 7714).

### Environmental Effects:

Ninety-six (96) hour LC<sub>50</sub> data range from 2,000 µg/L to 68,800 µg/L for grass shrimp and fathead minnows, respectively. During a 96-hour static bioassay, the LC<sub>50</sub> for bluegill sunfish was reported as 44,700 µg/L (U.S. EPA, 1980). Marine monitoring data suggest moderate bioconcentration (2 to 25 times). The bioconcentration factor (BCF) for bluegill sunfish and rainbow trout ranges between 17 and 39. The octanol/water partition coefficient (log K<sub>ow</sub>) is 9.29 (NLM, 1989). Low absorption coefficient (log K<sub>oc</sub> = 2.0) indicates a high level of soil transport and low potential for sediment absorption. A high value for Henry's Law (H<sub>c</sub>) Constant (-0.41) and several field studies support the occurrence of rapid evaporation from water.



**TETRACHLOROETHYLENE**  
**CAS NO. 127-18-4**

**Synonyms:**

Antisol 1  
Carbon Bichloride  
NCI-C04580  
NEMA  
PCE  
PERC  
Perchloroethylene  
Perclene  
PERK  
Tetlen  
Tetracap  
Tetropil  
VR 1897

**Chemistry and Uses:**

**Description:** Tetrachloroethylene, also known as perchloroethylene (PCE), is a colorless, tasteless liquid with a mildly sweet odor. PCE has a vapor pressure of 18.47 mm Hg at 25°C.

**Uses:** PCE is used in the textile industry as a dry cleaning agent. It is also used in vapor degreasing of metals. It enters the atmosphere as fugitive air emissions from dry cleaning and metal degreasing industries (NLM, 1989).

**Fate:**

When spilled on the land, PCE will evaporate into the atmosphere. It has a low to medium mobility in soil, but it may leach through sandy soils into the groundwater. PCE is not expected to hydrolyze. It may biodegrade in the soil under anaerobic conditions. It can also be transformed by reductive dehalogenation under anaerobic conditions to trichloroethylene, dichloroethylene, and vinyl chloride. The aquatic fate of PCE is loss by evaporation to the atmosphere. The half-life may vary from less than one day to several weeks. No significant hydrolyzation, biodegradation, bioconcentration in aquatic organisms, or absorption to sediment should occur. It decomposes slowly in water to yield trichloroacetic acid and hydrochloric acid. In the atmosphere, PCE exists mainly in the gas phase. It is subject to photooxidation with a half-life anywhere from 1 hour to 2 months. Some PCE may washout in the rain. The primary degradation product is phosgene (NLM, 1989).

### Human Health Effects:

Tetrachloroethylene is absorbed by inhalation of contaminated air and ingestion of contaminated drinking water. Inhalation is the principal route by which PCE enters the body, followed by the oral route. Dermal absorption is minimal by comparison. It is considered a probable human carcinogen currently under study (U.S. EPA, 1990). Once in the bloodstream, PCE tends to concentrate in human body fat and the brain. It may cause liver irregularities, respiratory tract irritation, conjunctivitis, dermatitis or inflammation of the skin, and depression of the central nervous system (NLM, 1989).

### Environmental Effects:

Available data for PCE indicate that acute and chronic toxicity to freshwater aquatic life can occur at concentrations around 840 and 5,280  $\mu\text{g/L}$ , respectively (U.S. EPA 1985). The bioconcentration factor (BCF) of tetrachloroethylene in fathead minnows is 38.9 and in bluegill sunfish is 49 (NLM, 1989). A 96-hour flow-through bioassay produced an  $\text{LC}_{50}$  of 18.4 mg/L for fathead minnows (Verschuere, 1983). An  $\text{LC}_{50}$  for *Daphnia magna* was reported at 18 mg/L during a 48-hour static bioassay (LeBlanc, 1980). Due to its high vapor pressure and low adsorption to soil, volatilization of PCE from dry soil should be rapid (Riddick et al., 1986). NOAEL and LOAEL was reported at 20 mg/kg/day (converted to 14 mg/kg/day) and 100 mg/kg/day (converted to 71 mg/kg/day), respectively [Buber and O'Flaherty, 1985].

**XYLENE**  
**CAS NO. 1330-20-7**

**Synonyms:**

Dimethyl Benzene  
Kaylen  
NCI - C55232  
VR 1307  
Xylol

**Chemistry and Uses**

**Description:** Xylene is a clear, tasteless volatile liquid with a sweet odor. Xylene, as referred to here, is a mixture of the ortho-, meta-, and para-isomers.

**Uses:** Xylene is used in the petroleum refining industry. It is also used as an industrial solvent and in the manufacturing of insect repellents, pharmaceuticals, and epoxy resins.

**Fate**

Xylene is released to the environment primarily from fugitive emissions and exhaust connected with its use in gasoline. When released to the soil, xylene will volatilize and leach into the ground. Xylene is moderately mobile in the soil and may leach into the groundwater. There is some evidence of biodegradation occurring in the soil, but the extent depends upon the concentration, residence time, nature of the soil, and the acclimation of microbial populations (U.S. EPA, 1989). Atmospheric degradation will occur by reaction with photochemically produced hydroxyl radicals. The half-life of this process may vary 1 to 1.7 hours in the summer and 10 to 18 hours during the winter (U.S. EPA, 1989).

The aquatic fate of xylene is primarily volatilization, with a half-life of 1 to 5.5 days. Some adsorption to sediment is expected to occur. Although there is some evidence of biodegradation in the groundwater, xylene has been known to persist for many years. The extent of degradation will depend on contaminant concentration, residence time in soil, soil characteristics, and whether microbial populations have been acclimated.

**Human Health Effects**

Vapors may cause irritation of the eyes, nose, and throat. Repeated or prolonged skin contact may cause dermatitis and defatting of the skin. Xylene is absorbed mainly through mucous membranes and the pulmonary system. Absorption through intact and broken skin also occurs readily. Xylene is a central nervous system depressant that produces lightheadedness, nausea, headache, and ataxia at low doses. Aspiration of liquid xylene may cause chemical pneumonitis, pulmonary edema, and severe hemorrhage. At higher doses, xylene causes confusion, respiratory depression, and coma. Exposure above 100 ppm causes conjunctivitis, nasal irritation, and sore throats. It is a strong respiratory irritant when present in high concentrations. Xylene is fetotoxic in rodents following maternal inhalation exposure. It is

teratogenic to mice and rats, and embryotoxic to rats. The brain, liver, lung, and heart were also affected during this exposure. The human oral LDLo has been reported at 50 mg/kg. OSHA has established an 8-hour weighted average (TWA) threshold limit value (TLV) of 100 ppm and a short term exposure limit (STEL) of 150 ppm for exposure to xylene (U.S. EPA, 1989).

#### Environmental Effects

Little bioconcentration of xylene is expected to occur. The log of the BCF for fish is 2.14-2.20. Log BCF for eels is 1.3. The octanol/water partition coefficient (log Kow) for xylene is 3.12-3.20. The LD<sub>50</sub> for goldfish during a 24-hr bioassay was reported at 13 mg/L (Verschueren, 1983). The NOAEL was listed as 250 mg/kg/day (converted to 179 mg/kg/day)[NTP, 1986].

**ETHYLBENZENE**  
**CAS NO. 100-41-4**

**Synonyms:**

Aethybenzol  
EB  
Ethylbenzeen  
Ethylbenzol  
NCI-C56393  
Phenylethane  
VR 1175

**Chemistry and Uses:**

**Description:** Ethylbenzene is a colorless, flammable liquid with a pungent odor. Due to its low vapor pressure (10 mm Hg at 79°F), ethylbenzene is not expected to volatilize readily.

**Uses:** Ethylbenzene is used in the manufacture of cellulose acetate, styrene, and synthetic rubber. It is also used as a solvent or diluent and as a component of automotive and aviation gasoline.

**Fate:**

The primary source of exposure is from the air especially in areas of high traffic. Ethylbenzene will decrease in concentration by evaporation and biodegradation. Representative half-lives are several days to 2 weeks. It is only adsorbed moderately by soil and may leach into the groundwater. When released onto soil, ethylbenzene will biodegrade slowly. Evaporation from water will occur rapidly into the atmosphere with a half-life ranging from several hours to a few weeks. After the population of degrading microorganisms becomes established, biodegradation will occur rapidly. The half-life for this process is 2 days. Ethylbenzene will be removed from the atmosphere principally by reaction with photochemically produced hydroxyl radical. Additional quantities will be removed by rain. Some ethylbenzene will be adsorbed by the sediment (NLM, 1989).

**Human Health Effects:**

Ethylbenzene liquid and vapor are irritating to the eyes, nose, throat, and skin. The liquid is a low grade cutaneous irritant, and repeated contact may produce a dry, scaly, and fissured dermatitis. Acute exposure to high concentrations may produce irritation of the mucous membranes of the upper respiratory tract, nose and mouth, followed by symptoms of narcosis, cramps, paralysis, and death due to respiratory failure. Effects of short-term exposure will lead to decreased manual dexterity and prolonged reaction time. Long-term overexposure may damage the liver and central nervous system.

Animals exposed through dermal and/or ingestive routes may suffer central nervous system depression. Guinea pigs exposed to concentrations of 1percent experienced ataxia, loss of

consciousness, tremors throughout the extremities, and finally death through respiratory failure. Rats given chronic oral doses of 408-680 mg/kg/day for 182 days suffered from liver and kidney abnormalities. Laboratory animals exposed to airborne concentrations ranging from 5,000 to 10,000 ppm had intense congestion and edema of the lung (NLM, 1989). Based on its octanol/water partition coefficient, ethylbenzene should not significantly bioconcentrate in aquatic organisms. Concentrations as low as 0.01 mg/L may lead to upper respiratory tract inflammation, nervous system disorders, and toxic hepatitis (Occ. Health and Safety Encyclopedia, 1983).

### Environmental Effects

LC<sub>50</sub>s of 12.1 and 32 mg/L have been reported for fathead minnows and bluegills, respectively (NLM, 1989). A bioconcentration factor of 37.5 has been reported for fish (U.S. EPA 1986). Reported 96-hr LC<sub>50</sub>s include 275 mg/L for sheepshead minnows (U.S. EPA., 1978) and 97.1 mg/L for guppies (Water Pollution Control Federation, 1966). Concentrations of less than 0.25 mg/L can cause tainting of fish flesh (Cleland, 1977). Based on the octanol/water partition coefficient of log K<sub>ow</sub> (3.15), the log BCF (2.16) in fish would indicate that ethylbenzene should not significantly bioconcentrate in aquatic organisms (Env. Behavior of Organic Compounds, 1982). The NOEL and LOAEL was reported as 136 mg/kg/day (converted to 97.1 mg/kg/day) and 408 mg/kg/day (converted to 291 mg/kg/day), respectively (NLM, 1991).

TOLUENE  
CAS No. 108-88-3

Synonyms:

Methyl Benzene  
Methacide  
Phenyl-methane  
NCI-C07272  
Toluol  
VR 1294

Chemistry and Uses:

Description: Toluene is a clear, colorless, non-corrosive liquid with a sweet, pungent, benzene-like odor. It has a vapor pressure of 20 mm Hg at 65°F.

Uses: Toluene is used in the manufacture of benzene, as a solvent for paints and coatings, as a component of automobile and aviation fuels, and as a chemical feed stock for numerous chemical manufacturing processes.

Fate:

Toluene is released to the atmosphere primarily from the volatilization of fuels, solvents, and thinners, and from motor vehicle exhaust. When toluene is released to the land it is lost by evaporation and microbial degradation. Toluene is relatively mobile in soil and can leach into the groundwater. Microbial degradation will not occur in the groundwater unless acclimated microorganisms are present. Toluene released to surface water will be lost by both volatilization and biodegradation. The water temperature, mixing conditions, and existence of acclimated microorganisms will determine which of these processes will be predominant. The half-life for toluene in surface water ranges from days to several weeks. Adsorption to the sediment and bioconcentration are low. Toluene which is released to the atmosphere degrades moderately rapidly by reaction with photochemically produced hydroxyl radicals, with a half-life ranging from 3 hours to slightly greater than 1 day. Toluene is very effectively washed out by rainfall and snow. Toluene does not absorb radiation greater than 290 nm, and therefore, is not subject to direct photolysis (U.S. EPA, 1989).

Human Health Effects:

Toluene vapor is readily absorbed by inhalation. The liquid is readily absorbed by the gastrointestinal tract, but poorly through the skin. Inhalation of the vapors causes headaches, slight drowsiness, nausea, and difficulty breathing. Extreme inhalation can result in death through paralysis of the respiratory system. Prolonged skin exposure causes irritation and possible dermatitis due to removal of natural lipids. Toluene appears to produce reversible effects on the liver, kidneys and nervous system, with the nervous system being the most sensitive. Toluene vapors cause a noticeable sensation of irritation to the human eye at 300-400 ppm in air. Eye damage may be irreversible.

### Environmental Effects

The  $LC_{50}$  for bluegills exposed to toluene was 17 mg/L for a 24-hour test and 13 mg/L for a 96-hour test. Fathead minnows had  $LC_{50}$ s of 56-63 mg/L in 24 hour tests and 34-59 in 96-hour tests. The  $LC_{50}$  for Daphnia magna was 313 mg/L in a 48 hour test. Toluene does not bioconcentrate significantly in fish and aquatic invertebrates. The log bioconcentration factor ranges from 0.22 to 1.12 (U.S. EPA, 1989).  $LD_{50}$  for a grain weevil was reported as 210 mg/L (Ferguson, 1948) as cited in the NRC, 1981). The NOAEL and LOAEL was 312 mg/kg (converted to 223 mg/kg/day) and 625 mg/kg (converted to 446 mg/kg/day), respectively (NTP, 1989).



PYRENE  
CAS NO. 129-00-0

Synonyms:

Benzo (D, E, F) Phenanthrene  
Beta - Pyrene

Chemistry and Uses:

Description: Pyrene is colorless and solid and has a slight blue color when in solution. It is fairly soluble in organic solvents.

Uses: Pyrene is used primarily in biochemical research. It is also used as a starting material for the synthesis of benzo(a) pyrene.

Fate:

Pyrene's release to the environment is ubiquitous since it is a product of incomplete combustion. It is largely associated with particulate matter, soils, and sediments. It is reasonably stable in the atmosphere and capable of long distance transport. If released to water, it will adsorb very strongly to sediments and particulate matter. If released to soil, it will not be expected to leach appreciably through to groundwater. It is not expected that pyrene will hydrolyze or significantly evaporate from soils and surfaces. Evaporation may be important, with a half-life of 4.8 to 39.2 days (NLM, 1991).

Human Health Effects:

Pyrene has not been classified as to its carcinogenicity (U.S. EPA, 1989). Cutaneous applications for 10 days caused hyperemia and weight loss. According to Potapova and others, rats at oral doses near the LD<sub>50</sub> succumbed in 2 to 5 days. Inhalation exposures lead to hepatic, pulmonary, and intragastric disorders.

Environmental Effects:

Pyrene will bioconcentrate in aquatic organisms slightly to moderately if released in water, but it will not hydrolyze. Bioconcentration is considered to be short term and not an important fate process. Reported BCF values for rainbow trout, goldfish, and fathead minnows are 72, 457 and 600-970, respectively (NLM, 1991). The NOAEL and LOAEL values were listed as 75 and 125 mg/kg/day, respectively (U.S. EPA, 1989).

**1,1,1-TRICHLOROETHANE**  
**CAS NO. 71-55-6**

**Synonyms:**

Acrothene TT  
Chloroetene  
Chloroethene  
Chloroethene NV  
Methyl Chloroform  
Methyltrichloromethane  
NCI-C04626  
Solvent 111  
Strobane  
TCA  
1,1,1-TCE  
Tri-ethane  
VR 2831

**Chemistry and Uses:**

**Description:** 1,1,1-Trichloroethane is a colorless, non-flammable liquid with a sweet odor.

**Uses:** 1,1,1-Trichloroethane is found in many products used in the home such as cleaners, adhesives, paints, and aerosol sprays (NLM, 1989).

**Fate:**

Due to its high vapor pressure (100 mm Hg at 20°C), 1,1,1-trichloroethane will evaporate fairly rapidly into the atmosphere. The half-life for aquatic fate will range from hours to a few weeks depending on wind and mixing conditions. 1,1,1-Trichloroethane is fairly stable in the atmosphere and is transported long distances. It degrades slowly by reaction with hydroxyl radicals with a half-life ranging from 6 months to 75 years. Atmospheric degradation is increased by the presence of chlorine radicals and nitrogen oxides. The amount of 1,1,1-trichloroethane in the atmosphere is increasing by 12-17percent annually. Some TCA is returned to the earth through rainfall. The adsorption of 1,1,1-trichloroethane to soil is proportional to the organic carbon content of the soil. The partition coefficient of 1,1,1-trichloroethane to five soils (organic carbon of 0.1 - 4.9percent) ranged from <0.05 to 0.5 l/g. Since it is frequently found in groundwater in high concentrations, one can conclude that it is not strongly adsorbed to soils (NLM, 1989).

### Human Health Effects

1,1,1-Trichloroethane is a central nervous system and respiratory depressant and an irritant to the skin and mucous membranes. Mild liver and kidney dysfunction may occur transiently following recovery from central nervous system depression (NLM, 1990). 1,1,1-Trichloroethane is absorbed rapidly through the lungs and gastrointestinal tract, but cutaneous absorption is probably too slow to produce significant toxicity unless the chemical is trapped against the skin by an impermeable barrier (NLM, 1989). It may cause transient increases in liver enzymes and translate renal impairment. There are no confirmed human or animal data that have lead to the classification of 1,1,1-trichloroethane as a carcinogen (U.S. EPA, 1990). The LD<sub>50</sub> for a female mouse was reported as 11.24 g/kg (Verschuieren, 1983). Mouse LD<sub>50</sub> was listed as 5080 mg/kg (U.S. EPA, 1982). Oral LD<sub>50</sub> of 5.66 g/kg was calculated for a female rabbit (Verschuieren, 1983). During an inhalation study, a mouse LC<sub>50</sub> was determined to be 13,500 ppm/10-hrs (Verschuieren, 1983).

### Environmental Effects

For a 96-hr bioassay, fathead minnows had an LC<sub>50</sub> of 52.8 mg/L for a flow-through test and 105 mg/L for a static test. The 7-day LC<sub>50</sub> reported for the guppy was 133 ppm. The bioconcentration factor in bluegill sunfish in a 28-day test was 8.9, indicating little tendency to bioconcentrate in fish (NLM, 1990). NOAEL and LOAEL was reported as 90 mg/kg/day and 120 mg/kg/day, respectively (Adams et al., 1950).

**ANTHRACENE**  
**CAS NO. 120-12-7**

**Synonyms:**

Anthracen  
Anthracin  
Paranaphthalene  
Green Oil  
Tetra Olive R2G

**Chemistry and Uses:**

**Description:** Anthracene is a clear, white crystal with violet fluorescences.

**Uses:** Anthracene is used in the preparation of alizarin dyes and anthraquinone. It is also used in the manufacture of fast dyes and synthetic fibers.

**Fate:**

Anthracene occurs in exhaust from motor vehicles, cigarettes, and cigar smoke. Atmospheric emissions from coal, oil and wood burning stoves, furnaces, power plants, soot, and charcoal broiled foods are common. Since anthracene releases are quite general and it has extensive natural and anthropogenic sources, anthracene is ubiquitous in the environment. It is largely associated with particulate matter, soils, and sediments. In soils, it can be expected to adsorb strongly to soil and will not be expected to leach to groundwater. It may, nevertheless, evaporate from soil and other surfaces. If released to the atmosphere, the estimated vapor phase half-life is 1.67 days, whereas in water an estimated range of half-lives of 4.3-5.9 days has been predicted.

**Human Health Effects:**

Anthracene exerts a phototoxic and photoallergic effect on human skin. It can cause acute dermatitis with burning, itching, and edema. Skin damage also is associated with irritation of the conjunctiva and upper airways. Systemic effects of industrial anthracene include nausea, loss of appetite, slow reactions, and adynamia. Prolonged effects include gastrointestinal inflammation. Anthracene has not been classified as to human carcinogenicity (U.S. EPA, 1991).

**Environmental Effects:**

Anthracene may bioconcentrate in species which lack microsomal oxidase. BCF values for goldfish and rainbow trout are 162 and 4400-9200, respectively (NLM, 1991). The whole fish BCF according to Spacie et al., (1983) was reported as 900.

ZINC  
CAS NO. 7440-66-6

Synonyms:

Zn  
Blue Powder  
Jasad  
Merrillite  
Pasco  
Pigment Black 16  
VR 1383  
VR 1436

Chemistry and Uses:

**Description:** Zinc is a bluish-white, lustrous metal. Pure zinc powder, dust and fume is relatively non-toxic to humans by inhalation. It is incompatible with chlorates, acids, oxidizers and sodium hydroxide.

**Uses:** Zinc is used as a protective coating for metals to prevent corrosion. It is also used as purifying agent for soaps.

Fate:

No information is available for environmental fate through the National Library of Medicine database for zinc.

Human Health Effects:

Humans can be exposed to zinc primarily through drinking water, and ingestion of food containing zinc. Zinc poisoning can occur with prolonged consumption of water from galvanized pipes. Muscular stiffness and pain, loss of appetite, and nausea were reported among individuals who drank water that contained 40 mg/L of zinc for an extended period of time. Ingestion of apples stewed in galvanized iron vessels containing 7g zinc resulted in dizziness, nausea, tightness in the throat, and in some cases diarrhea. Dermal exposure of 300 µg/3 days resulted in mild skin irritation (NLM, 1991).

Environmental Effects:

Bioconcentration factors (BCFs) in mollusks are extremely variable. The BCF in edible portions of adult oysters Crassostrea virginia is 16,700, whereas in the soft shell clam Mya arenaria it is 85 and in Mytilus edulis the BCF value is 500 (NLM, 1991). The LC<sub>50</sub> for fish ranges from 430 to 9200, depending on the species (Barnthouse et al., 1986).

**COPPER**  
**CAS NO. 7440-50-8**

**Synonyms:**

ANAC 110  
Bronze Powder  
CDA 101  
CDA 102  
CDA 110  
CDA 122  
1721 Gold  
Gold Bronze  
Kafar Copper  
Cu  
Ranery Copper

**Chemistry and Uses**

**Description:** Copper is a reddish, malleable metal that is naturally occurring in rocks, soil, water, sediment, and air. It is insoluble and classified as a non-combustible solid.

**Uses:** Copper is an essential nutrient for all living organisms. It is most commonly used in electrical wiring, water pipes, and the U.S. penny. Copper is also found as a bronze and brass alloy.

**Fate:**

Copper is released to the atmosphere in the form of particulate matter or adsorbed to particulate matter. It is removed by bulk and dry deposition, washout by rain, and rainout. Most copper deposited in soil from the atmosphere, agricultural use, and solid waste and sludge disposal will be strongly adsorbed and remain in the soil. Much of copper discharged via water is in particulate form and settles out, precipitates out, or adsorbs to organic matter, hydros iron and manganese oxides, and clay in sediment or in the water column. Copper binds primarily to organic matter in estuarine sediment.

### Human Health Effects:

Copper has little or no toxicity, but inhalation of fumes and dust can irritate the upper respiratory tract causing congestion of mucous membranes, ulceration, and perforation of the nasal septum. In severe cases, inhalation of fumes can cause nausea, gastric pain, diarrhea, and sometimes poisoning. Ingestion of high concentrations of copper can induce acute gastrointestinal disturbance including vomiting, diarrhea, stomach cramps, and nausea. Long-term exposure to excessive amounts of copper in food or water by young children can result in liver damage and death. The LD<sub>50</sub> in mice has been found to be 3,500 µg/kg.

### Environmental Effects:

The bioconcentration factor (BCF) of copper in fish is 10-100, indicating a low level. the BCF in mollusks is much higher and for oysters can reach 30,000. Nevertheless, copper does not appear to exhibit biomagnification in the food chain. The biomagnification ratio (concentration of copper in fish to that in potential food) was < 1, indicating no biomagnification. Studies of bioaccumulation in 10 mammalian species at various trophic levels reported similar findings. In fish, the LC<sub>50</sub> ranges from 75-470 µg/L during the adult lifestage, depending on the species. During early lifestage, rainbow trout were found to have a LC<sub>50</sub> value of 80 µg/L (Barnthouse, 1986).

**POLYCYCLIC AROMATIC HYDROCARBONS**  
**CAS NOS. 50-32-8, 207-08-9 and 218-01-9**

**Synonyms/Specific Chemical Names:**

**PAHs**

**Benzo (a) anthracene**

**Benzo (k) fluoranthene**

**Benzo (a) pyrene**

**Chrysene**

**Fluoranthene**

**Phenanthrene**

**Chemistry and Uses:**

**Description:** Polycyclic aromatic hydrocarbons (PAHs) are a group of chemicals, which in their pure form, exist as colorless, white or pale yellow-green solids. They are formed during incomplete combustion of coal, oil, garbage, or other organic substances. PAHs occur as vapors or can be attached to dust or other particles in the air.

**Uses:** Common sources of PAHs are vehicle exhaust, asphalt roads, coal tar, wildfires, agricultural burning, cooked foods, grains, flour, meat, fruit, processed or pickled foods, and beverages.

**Fate:**

PAHs are ubiquitous throughout the environment and found in air, water, and soil. PAHs are capable of short and long-term transport and are removed by wet and dry deposition; the relative importance of each process varies with the individual PAH being examined. In the atmosphere, PAHs are present in the gaseous phase or sorbed to particulates. Atmospheric residence time and transport distance are dependent on the size of the particle to which the PAH is sorbed. Atmospheric half-life is generally less than 30 days (ATSDR, 1991).

Because of their low solubility, PAHs in aquatic systems are generally found sorbed to bottom particles or suspended in the water column. PAHs are removed from the water column by volatilization to the atmosphere, and subsequently binding to particulates or sediments. They also can accumulate or sorb onto aquatic biota. Sorption of PAHs to soil and sediments increases with increasing organic carbon content and is dependent on particle size. PAHs found in groundwater may occur as a result of migration from contaminated surface waters or through the soil.



### Human Health Effects:

Certain PAHs may be carcinogenic to humans. Cancer associated with exposure to mixtures containing PAHs occurred primarily in the lung and skin following inhalation and dermal exposure, respectively. Cancerous effects have generally not been observed in humans (with the exception of adverse hematological and dermal effects) but have been found in animals. In animals, PAHs tend to affect tissue such as bone marrow, lymphoid organs, gonads, and intestinal epithelium. Major target organics in animals appear to be hematopoietic and lymphoid systems.

No reports of death from exposure to PAHs have been made. Nevertheless, benzo(a) pyrene has been found to be fatal to mice following ingestion. Adverse non-cancer respiratory effects have not been reported in humans although inhalation is a significant route of exposure, and the respiratory system appears to be a target for PAH-induced cancers. Therefore, it seems likely that PAH-induced noncancerous effects may occur in humans as well. Rats administered 0.6  $\mu\text{g/L}$  benzo(a)pyrene adsorbed on  $\text{Ga}_2\text{O}_3$  particles as an aerosol and as an aerosol only, showed 20 percent deposition on the lung with the tracer and 10 percent as an aerosol after 30 minutes, and over a 2-week period, the hydrocarbon was removed from the lung via mucociliary clearance and absorbed. With the aerosol only it was removed and transported directly to the blood. There was an increase in benzo(a)pyrene in the alimentary tract, thus converting it to the stomach, liver, and kidneys relative to the pure benzo(a)pyrene (NLM, 1991).

The skin is susceptible to PAH-induced toxicity in both humans and animals. Workers exposed to PAHs experienced chronic dermatitis and hyperkeratosis. In animals, destruction of sebaceous glands, skin ulcerations, hyperplasia and hyperkeratosis, and alternations in epidermal cell growth were found. Application of 2 percent crude coal tar to the skin of humans for 8 hour periods for 2 days resulted in absorption of PAHs. Phenanthrene, anthracene, pyrene, and fluoranthene were detected in the blood but benzo(a)pyrene was not. Systemic absorption of PAHs from the skin is variable among these compounds (ATSDR, 1991).

The testes and ovaries should be considered as susceptible to damage from PAHs. Scrotal cancer was observed among chimney sweeps most likely from exposure to soot containing PAHs. Women of childbearing age may be at increased risk to reproductive or ovarian dysfunction from exposure to PAHs.

Some PAHs may also be genotoxic, the most widely tested being benzo(a)pyrene. Benzo(a)pyrene caused several types of genotoxic effects during in vitro assays of human cells. Chrysene and fluoranthene have also shown similar results. Synergistic and/or antagonistic effects from combinations of PAHs, particularly in respect to carcinogenesis, may occur (ATSDR, 1991).

### Environmental Effects:

In surface water, PAHs can volatilize, photodegrade, oxidize, biodegrade, bind to particulates, or accumulate in aquatic organisms, enter groundwater, and be transported through the aquifer. Bioconcentration factors of 100-2,000 are typical for this group of chemicals. In sediment and soil, PAHs can biodegrade and accumulate in aquatic organisms or plants, respectively. Biomagnification has not been reported because of the tendency for many organisms to eliminate these compounds rapidly.

PAHs in sediments can accumulate in bottom-dwelling invertebrates and fish. They can also accumulate in terrestrial plants via roots or foliage. PAHs can accumulate in animals through the food chain or by ingestion of soil.

**1,3,5-TRINITROBENZENE**  
**CAS NO. 99-35-4**

**Synonyms:**

Benrite  
TRB  
Trinitrobenzeen  
Trinitrobenzene  
Trinitrolbenzol  
RCRA Waste # V234

**Chemistry and Uses:**

Description: 1,3,5-Trinitrobenzene is a slightly yellowish crystal.

Uses: 1,3,5-Trinitrobenzene is used primarily in the manufacture of explosives. It is also used to vulcanize natural rubber and as a pH indicator in the range of 12.0 - 14.0

**Fate:**

If released to the soil, 1,3,5-trinitrobenzene is expected to be moderately to highly mobile. It has the potential to photolyze on soil surfaces (NLM, 1992). Water-bound 1,3,5-trinitrobenzene may be subject to direct photolysis. Based on a extrapolated vapor pressure of  $3.2 \times 10^{-6}$  mm Hg at 20°C, 1,3,5-trinitrobenzene is expected to exist partly in the vapor phase and partly adsorbed onto particulate matter in the atmosphere (NLM, 1992). A water solubility of 340 mg/L at 20°C suggests that wet deposition may be a potential fate process.

**Human Health Effects:**

1,3,5-Trinitrobenzene may cause optic disorders. Chronic intoxication has been reported to cause yellowing of the conjunctiva. Routes of entry for human exposures are skin contact, inhalation, and ingestion. Severe explosion hazards may develop when shocked or exposed to heat. When heated to decomposition, highly toxic fumes of nitrous oxides may be produced. It is incompatible and will react violently with reducing materials.

**Environmental Effects**

Based on a log octanol/water partition coefficient of 1.18 and a water solubility of 340 mg/L at 20°C, bioconcentration factors of 5 and 23 have been estimated. Adsorption coefficients of 104 and 178 suggest that 1,3,5-trinitrobenzene has moderate to high soil mobility and exhibits low adsorption to suspended solids and sediments (NLM, 1992).

CHLOROFORM  
CAS NO. 67-66-3

Synonyms:

Formyl Trichloride  
Methane Trichloride  
Trichloromethane  
NCI-C02686  
R 20  
ICM  
VR 1888

Chemistry and Uses:

**Description:** Chloroform is a clear, colorless, and mobile liquid with a characteristic odor and a sweet taste. It is slightly soluble in water (5 ml/L) and has a high vapor pressure (100 mg Hg at 10.4°C). Chloroform is nonflammable, but will burn on prolonged exposure to flame or high temperature. It will decompose to form hydrochloric acid, phosgene, and chlorine upon contact with flame.

**Uses:** Most of the chloroform manufactured in the United States (93 percent) is used to make fluorocarbon-22 (ATSDR, 1989b). Chloroform is also used as a grain fumigant; a chemical intermediate for dyes and pesticides; and a solvent for pesticides, adhesives, oils and other compounds. It was previously used as a surgical anesthetic and as an ingredient in cough syrups, toothpastes, and liniments, but the FDA has banned the use of chloroform in drugs, cosmetics, and food packaging (NLM, 1989).

Fate

Chloroform that is released to the atmosphere may be transported long distances before being degraded by reaction with photochemically generated hydroxyl radicals. The half-life for this reaction is approximately 3 months. Removal of chloroform from the atmosphere in precipitation may be significant; however, most of this chloroform will reenter the atmosphere through volatilization. Volatilization is the primary fate process for chloroform released to water, with a half-life of 1-31 days. Chloroform released to the soil will either volatilize rapidly or leach readily through the soil and enter the groundwater. Chloroform will adsorb strongly to peat moss, less strongly to clay and limestone, and not at all to sand. Chloroform is predicated to persist in the groundwater for relatively long periods of time (ATSDR, 1989b).

### Human Health Effects:

Chloroform is absorbed readily through the lungs and intestines. The three principal target organs of chloroform toxicity are the liver, kidneys, and central nervous system. Short-term exposure to high concentrations of chloroform in the air can cause fatigue, dizziness, and headache. Other symptoms of chloroform exposure include respiratory depression, coma, kidney and liver damage, and death. Rapid death is attributable to cardiac arrest, while delayed death results from kidney or liver damage (ATSDR, 1989). Chloroform is classified as a probable human carcinogen. It is considered highly fetotoxic, but not teratogenic (U.S. EPA, 1990). Two studies of rates exposed to chloroform at 25-30 ppm for 7 hours/day, 5 days/week for 6 months resulted in no adverse organ conditions. Liver and kidney damage appeared at exposure levels of 50 ppm (ACGIH, 1986). An oral LD<sub>50</sub> for a rat and dog was reported at 2,180 mg/kg and 2,250 mg/kg, respectively (Larson, 1985).

### Environmental Effects:

The bioconcentration factor of chloroform in four different fish species was found to be less than 10 times the concentration in ambient water, suggesting little tendency for chloroform to bioconcentrate in aquatic organisms. A 27-day flow-through test showed an LC<sub>50</sub> in rainbow trout of 2030 µg/L in soft water and 1,240 µg/L in hard water. Static 96-hour tests showed LC<sub>50</sub>s of 43,800 µg/L for rainbow trout and 100,000 µg/L for bluegills (NLM, 1989). During a 48-hour static bioassay, an LC<sub>50</sub> for Daphnia magna was reported at 28,900 µg/L (U.S. EPA, 1980). The LOAEL value was listed as 15 mg/kg/day (Converted to 12.9 mg/kg/day) [Heywood et al, 1979].

**2,4,6-TRINITROTOLUENE**  
**CAS NO. 118-96-7**

**Synonyms:**

2-Methyl-1,3,5-Trinitrobenzene  
Entsufon  
TNT  
Alpha-TRT  
TRT-tolite  
Tolit  
Tolite  
2,4,6-Trinitrotolueen  
Trinitrotoluene  
NCI-C561155

**Chemistry and Uses:**

**Description:** 2,4,6-Trinitrotoluene is a colorless to light yellow crystal or flake. It is classified as a highly explosive and combustible solid.

**Uses:** It is primarily used in the production of explosives.

**Fate:**

The capability of microorganisms to biotransform 2,4,6-trinitrotoluene is well established. Reduction rates under aerobic conditions are very slow. 2,4,6-Trinitrotoluene is not expected to hydrolyze in soils or groundwater. Based on an average Koc of 1600, soil mobility is expected to be low. Studies comparing river waters and distilled water have shown that the rate of photolysis is directly related to increases in pH and organic matter content. The vapor pressure of  $1.99 \times 10^{-4}$  mm Hg at 20°C indicates that 2,4,6-trinitrotoluene exists almost entirely in the vapor phase (NLM, 1992). At an atmospheric concentration of  $5 \times 10^{-5}$  hydroxyl radicals per cm<sup>3</sup>, the atmospheric half-life is estimated to be approximately 110 days (NLM, 1992).

**Human Health Effects**

Exposure to 2,4,6-trinitrotoluene may cause irritation to the eyes, nose, and throat with sneezing, cough, and sore throat. Skin contact may lead to severe dermatitis and may stain the skin and nails. Other symptoms include weakness, drowsiness, unconsciousness, muscular pains, heart irregularities, and cataracts. Numerous fatalities have occurred due to toxic hepatitis and anemia.

### Environmental Effects:

A bioconcentration factor of 11.5 was determined from an estimated oil/water partition coefficient. Based on a water solubility of 130 ppm at 20°C, the BCI factor was estimated at 40 (NLM, 1992). Reported 48-hour LC<sub>50</sub>s include 11.7 mg/L for Daphnia magna and 6.5 mg/L for Hyabella azctia. A 96-hour bio-assay resulted in an LC<sub>50</sub> of 2.58 mg/L for fathead minnows (NLM, 1992).

**2,4-DINITROTOLUENE**  
**CAS NO. 121-14-2**

**Synonyms:**

1-Methyl-2,4-Dinitro Benzene  
2,4-Dinitrotoluol  
2,4-DNI

**Chemistry and Uses:**

**Description:** 2,4-Dinitrotoluene is a yellow to red solid with a characteristic odor. It may be in the form of a yellow liquid. Is classified as a combustible solid, but is difficult to ignite. 2,4-Dinitrotoluene is incompatible with strong oxidizers, caustics, and metals. Commercial grades will decompose at 482 °F with self-sustaining decomposition at 536°F.

**Uses:** 2,4-Dinitrotoluene is used by the munitions industry as a modifier for smokeless powders. It is also used as a plasticizer in moderate or explosives and in the manufacture of rubber chemicals and plastic.

**Fate:**

An estimated soil adsorption coefficient ( $K_{oc}$ ) of 282 indicates the potential for slight mobility in the soil (NLM, 1992). Photolysis is probably the most significant removal process of 2,4-dinitrotoluene in water. Photolytic half-lives in rivers, bays, and pond waters were 2.7, 9.6, and 3.7 hours, respectively (NLM, 1992). The measured log Kow value of 1.98 reflects that 2,4-dinitrotoluene has a slight tendency to adsorb to sediments, suspended solids, and biota.

**Human Health Effects:**

The effects from exposure to 2,4-dinitrotoluene may include headaches, irritability, dizziness, nausea, and unconsciousness. It is also noted to cause systemic intoxication (NLM, 1992). the onset of symptoms may be delayed. Repeated or prolonged exposure may cause anemia. Skin absorption is the primary exposure route. Alcohol ingestion may lead to an increased susceptibility.

**Environmental Effects:**

Reported 96-hour bioassay for fathead minnows resulted in LC<sub>50</sub>'s of 24.3 mg/L and 31,000 mg/L, respectively (NLM, 1992).



**ARSENIC**  
(CAS NO. 7440-38-2)

Synonyms:

Arsenicals

Arsen

Arsenic Black

Metallic arsenic

Arsenic-75

Arsenic, solid

Colloidal arsenic

UN 1558

Chemistry and Uses:

**Description:** Arsenic is a silvery, gray, crystalline material with a very high melting point. It is virtually insoluble in water and body fluids.

**Uses:** Arsenic is used in metallurgy for the hardening of copper, lead, and alloys. It is also used in the manufacture of certain types of glass and in medical applications (Merck & Co. 1968).

Fate:

**Releases to the environment:** Arsenic can enter aquatic media through wet and dry deposition, runoff from soils and from industrial discharges. The major source of atmospheric arsenic is coal combustion. The element enters soil from wet and dry precipitation of atmospheric arsenic, runoff of surface waters, and disposal of arsenic containing waters. Arsenic in aquatic sediments can become biologically available via methylation by bacteria (Lemo et al. 1983).

**Soil:** Arsenic occurs in soil predominantly in an insoluble adsorbed form. Leaching of arsenic is usually only important in the top 30 centimeters of soil. Arsenate dominates in aerobic soils, while arsenite is predominant in slightly reduced soils. Arsine, methylated arsenic, and elemental arsenic predominate in very reduced conditions.

**Groundwater:** Soluble forms of arsenic travel with the groundwater mass with which they are associated. Volatilization of methylated forms in groundwater is possible.

**Surface Water:** Arsenic released into surface water can undergo a complex pattern of transformations, including oxidation-reduction reactions, ligand exchange, biotransformation, precipitation, and adsorption. This complexity results in extremely mobile behavior in aquatic systems, with much of the arsenic entering rivers being transported to oceans. Sorption onto clays, iron oxides, manganese compounds, and organic material is an important fate of arsenic in surface water, and sediment serves as a reservoir for much of the arsenic entering surface waters.

**Atmospheric:** Arsenic released into the atmosphere as a gas vapor or adsorbed to particulate matter may be transported to other media via wet or dry deposition. Trivalent arsenic may undergo oxidation in air. Most arsenic in air is adsorbed to particulate matter. Photolysis is not considered an important fate process for arsenic compounds.

### Human Health Effects:

**Routes of Entry:** The major routes of entry for human exposure to arsenic are through ingestion and inhalation. Inorganic arsenic compounds are found to be almost completely absorbed by the gastrointestinal tract but absorption of other complexes of arsenic vary from 40 to 90 percent. Arsenic is poorly absorbed through the skin. Absorbed arsenic is promptly distributed in various organs and is stored in the bones, skins, and keratinized tissues. It tends to accumulate in the liver, from which it is slowly released.

**Noncarcinogenic Effects:** Chronic intake of arsenic in humans is associated with skin disorders and peripheral circulatory diseases. The concentrations of arsenic in drinking water, associated with peripheral circulatory disease, ranged from .001 to 1.82 mg/L.

Acute toxicity of the arsenic compound  $\text{As}_2\text{O}_3$  varies from 8 to 500 mg/kg body weight (Harrison 1958). LD50 values range from 15.1 to 23.6 mg/kg in solution and 145.2 to 214 mg/kg dry (non solution form) for the rat, and from 39.4 to 42.6 mg/kg for the mouse (Clayton 1981). Marked hemorrhaging of the gastrointestinal tract as well as fatty degeneration of liver cells and cellular necrosis has been reported.

**Carcinogenic Effects:** U.S. EPA has classified arsenic as a human carcinogen. This is based on observation of increased lung cancer mortality in populations exposed primarily through inhalation and on increased skin cancer incidence in several populations consuming drinking water with high arsenic concentrations.

### Environmental Effects

**Aquatic Toxicity:** Acute toxicities for aquatic organisms tested with sodium arsenite showed LD50 values of 1,044 and 812  $\mu\text{g/L}$  for the water fleas Daphnia magna and Simocephalus serrulatus, respectively. Rainbow trout (Salmo gairdneri) and bluegills (Lepomis microchirus) had values of 13,340 and 41,760  $\mu\text{g/L}$ , respectively. A 96-hour  $\text{LC}_{50}$  of 21,200  $\mu\text{g/L}$  for bluegill is reported in the U.S. EPA Ambient Water Quality Criteria document. Sodium arsenate produced values of 7,400  $\mu\text{g/L}$  for cladoceran and 10,800  $\mu\text{g/L}$  for rainbow trout. Monodosium methane arsenate  $\text{LC}_{50}$  values ranged from 506,000 to 1,403,000  $\mu\text{g/L}$  for the crayfish (Procambarus sp.) and the channel catfish (Ictalurus punctatus). Values for the fathead minnow are reported to range from 14,900-82400  $\mu\text{g/L}$  (NLM 1989). Barnhouse and Suter (1986) reported chronic toxicity values of 2,130 (NOEC) and 4,300 (LOEC)  $\mu\text{g/L}$  for fatheads with a MATC of 3,026  $\mu\text{g/L}$ . Aquatic organisms accumulate arsenic but do not biomagnify it.

**Terrestrial Toxicity:** Plants may accumulate arsenic via root uptake from soil solution and certain species may accumulate substantial levels.

**IRON**  
**(CAS NO. 7439-89-6)**

**Description:** Iron is considered an essential human nutrient. No other information is available from the National Library of Medicine Database.

**Uses:** No information on use is available from the National Library of Medicine Database.

**Fate:**

**Releases to the Environment:** No information is available on the environmental fate of iron in the National Library of Medicine Database.

**Human Health Effects:**

**Routes of Entry:** Little information is available concerning the adverse health effects of exposure to iron. Long-term inhalation exposure to iron caused mottling of the lungs, a conditions known as siderosis. Metallic iron foreign bodies in the cornea caused a "rust ring" of yellow-brown staining, associated with irritation of the conjunctiva (NLM 1991).

**Environmental Effects:**

No information is available on environmental effects of iron in the National Library of Medicine Database.

**SILVER**  
**(CAS #7440-22-4)**

**Chemistry and Uses**

**Description:** Silver is a rare element, which occurs naturally in its pure form as a white ductile metal and in ores. It has an average abundance of about 0.1 ppm in the earth's crust and about 0.3 ppm in soils. It also occurs in powdery white or dark-gray to black compounds.

**Uses:** Silver is used for making jewelry, dental fillings, and electronic equipment. Photographers use silver compounds to make photographs.

**Fate**

Silver is released into the air and water through natural processes such as weathering of rocks and erosion of soils. Important sources of atmospheric silver from human activities include the processing of ores, steel refining, cement manufacture, fossil fuel combustion, municipal waste incineration, and cloud seeding. Photographic sources and releases from disposal of sewage sludge are the major source of releases of silver into the environment. Silver remains stable in the environment until it is removed by human activities.

**Soil:** Silver tends to form complexes with inorganic chemicals and humic substances in soils. The transport and partitioning of silver in soils is influenced by the particular form of the compound. The mobility of silver in soils is affected by drainage, pH conditions, and a number of other factors. The enhanced ability of organic matter to immobilize silver is demonstrated by increases in levels of silver found in peat and bog soils and in marshes. Since silver is toxic to soil microorganisms and inhibits bacterial biodegradative enzymes, biotransformation is not expected to be a significant process.

**Groundwater:** Leachates containing silver may enter groundwater when tailing ponds or piles are situated in areas with high water tables or when abandoned mines or sections of mines become saturated.

**Surface Water:** In fresh water, silver may form complex ions with chlorides, ammonium, and sulfates. It may also become adsorbed onto humic complexes and suspended particulates and become incorporated into or adsorbed onto aquatic biota.

**Air:** Silver is released into the atmosphere as an aerosol. Particulates of metallic silver emitted from the burning of fossil fuels and municipal refuse are likely to become coated with silver oxide, or other silver compounds. Fine particles tend to be transported long distances and are deposited by deposition.

## Human Health Effects

**Routes of Entry:** Routes of entry for silver include ingestion, inhalation, and dermal. Usually, silver enters the body through the ingestion of food or drinking of water that contains silver, or through inhalation after breathing air that contains silver. It can also enter the body through the dermal route when there is exposure to solutions or powders containing silver compounds.

**Noncarcinogenic Effects:** Exposure to dust containing relatively high levels of silver compounds can cause breathing problems, lung and throat irritation, and stomach pain. Eating or breathing silver compounds over a long period of time can also cause argyria, a skin condition whereby the skin turns gray or blue-gray. Studies in rats show that swallowing water containing very large amounts of silver (25890 ppm) can be life threatening.

U.S. EPA has developed a reference dose for silver ( $3\text{E-}3$  mg/kg/day) based on the assumption that thresholds exist for certain toxic effects such as cellular necrosis, but may not exist for other toxic effects such as carcinogenicity.

**Carcinogenic Effects:** U.S. EPA has not classified silver as a carcinogen.

## Environmental Effects:

**Aquatic Toxicity:** Silver accumulation in marine algae appears to result from adsorption rather than uptake; bioconcentration factors of 13,000-16,000 have been reported. Bioconcentration factors of 1,055-7,650 wet weight were estimated in mussel in salt water. The clam contained silver at 32-133  $\mu\text{g/g}$ . Silver from sewer sludge at an ocean disposal site was bioaccumulated by scallop (*Placopecten magellanicus*). The estimated biological half-lives for the elimination of bioaccumulated silver were 26.4 days for the Pacific oyster (*Crassostrea gigas*) and 149.1 days for the American oyster (*C. virginica*).

**Terrestrial Toxicity:** In pasture plants growing in the vicinity of an airborne source of silver, silver in leaves appears to be the result of deposition of airborne silver, while concentrations in roots are from soil uptake.

RDX  
Hexahydro-1,3,5-trinitro-1,3,5-triazine  
CAS NO. 121-82-4

Synonyms:

Cyclonite  
Cyclotrimethylenenitramine  
Cyclotrimethylenetrinitramine  
Cyklonit  
Esaidro-1,3,5-trinitro-1,3,5-triazina  
Heksogen  
Hexahydro-1,3,5-trinitro-1,3,5-triazin  
Hexahydro-1,3,5-trinitro-1,3,5-triazine  
Hexahydro-1,3,5-trinitro-s-triazine  
Hexogeen  
Hexogen  
Hexogen 5w  
Hexolite  
Hexolite, dry or containing, by weight, less than 15percent water  
Ne triamine  
1,3,5-trinitrohexahydro-s-triazine  
1,3,6-trinitro-1,3,5-triazacyclohexane  
UN 0072  
UN 0118  
PBX(af) 108  
PBXW 108(e)  
RDX  
T4  
1,3,5-triazine, hexahydro-1,3,5-trinitro-  
S-triazine, hexahydro-1,3,5-trinitro-  
Trimethyleentrinitramine  
Trimethylenetrinitramine  
Sym-trimethylenetrinitramine  
Trinitrocyclotrimethyle

Chemistry and Uses:

Description: RDX is a white crystalline powder, which is insoluble in water, alcohol, and benzene; but is slightly soluble in ether, methanol, and toluene.

Uses: RDX is used as a high explosive, a detonator, and sometimes as a rat poison.

### Fate:

Releases to the environment: RDX is released through demilitarization of antiquated munitions, or during the manufacture or conversion to munitions. Routes of human exposure include inhalation, ingestion, and dermal contact (skin and eye).

When released to soil, RDX is expected to exhibit moderate to high mobility in soils. Biodegradation, volatilization, and hydrolysis are not important processes in the fate of RDX. Under proper conditions, anaerobic degradation is known to occur (NLM, 1992).

Direct photochemical degradation by sunlight occurs if RDX is released to water. The half-life of RDX in translucent waters is on the order of a few weeks. For RDX, bioaccumulation in aquatic organisms and volatilization to the atmosphere should not be a significant fate process (NLM, 1992).

RDX released to the atmosphere will undergo degradation by reaction with photochemically produced hydroxyl radicals. The vapor phase half-life can be estimated about 1.5 hours. Direct photochemical degradation should also be important process (NLM, 1992).

### Human Health Effects

Exposure to RDX occurs through inhalation, ingestion, and skin and eye contact. RDX is slowly absorbed from the stomach and the lungs. Symptoms include headache, dizziness, nausea, and intermittent stupor. Recovery was eventually complete. Human illness results from repeated exposure via G.S. and respiratory tract. Dermatitis resulted from handling intermediates of RDX.

### Environmental Effects

The minimum LD<sub>50</sub> for rats in a single dose of 4percent solution was 200 mg/kg. Toxicity effects on survival at 4.9-6.3 mg/L during chronic exposure of fathead minnows.

Symptoms in animals ranged from twitching with mild hyperreflexia to severe convulsions.

The bioconcentration factor in bluegills was determined to be 24.8, suggesting that bioaccumulation in aquatic organisms should not be an important fate process.

An LC<sub>50</sub> of 3.6 mg/L/96 hour in a static bioassay was reported for bluegills.

**2,6-DINITROTOLUENE**  
**CAS NO. 606-20-2**

**Synonyms:**

**2,6-DNT**  
**Benzene, 2-methyl-1,3-dinitro**

**Chemistry and Uses:**

**Description:** 2,6-DNT is a yellow to red solid with a slight odor. It is soluble in alcohol.

**Uses:** 2,6-DNT is used as a gelatinizing and waterproofing agent in explosives. It also is used in the synthesis of TNT, urethane polymers, foams, coatings, and dyes.

**Fate:**

**Releases to the Environment:** 2,6-DNT can enter the body by ingestion, inhalation of vapor, and percutaneous absorption of liquid.

**Soil:** The calculated K<sub>ox</sub> 204 and an estimated log K<sub>ow</sub> of 1.72 indicate that 2,6-DNT is slightly mobile in soil (NLM, 1992).

**Groundwater:** No information could be found on the mobility of 2,6-DNT in groundwater.

**Surface Water:** Photolysis may be the most significant removal mechanism for 2,6-DNT in water. The estimated log K<sub>ow</sub> of 1.72 indicates that 2,6-DNT may sorb to sediments, suspended solids and biota to a limited extent.

**Atmosphere:** A computer estimated atmospheric half-life for 2,6-DNT is 8 hours (NLM, 1992).

**Human Health Effects:**

**Routes of Entry:**

**Noncarcinogenic Effects:** The primary subacute toxic effects occur in the red cells, nervous system, and tests (NLM, 1992). It is mutagenic in the Ames test. Reproductive effects were observed in dogs, rats, and mice. A 4 mg/kg oral dose in the dog produced inhibited muscular coordination, decreased appetite, and weight loss. It is a possible inductor of adverse reproductive effects in humans.

**Carcinogenic Effects:** 2,6-DNT is a potent hepatocarcinogen in rats and is regarded by the National Institute for Occupational Safety and Health as a potential human carcinogen.



**Environmental Effects:**

**Aquatic Toxicity:** A bioconcentration factor of 5225 was measured for the algal biomass in a model waste stabilization pond.

**Terrestrial Toxicity:** No information could be found.

**THALLIUM**  
(CAS NO. 7440-28-0)

Synonyms:

None

Chemistry and Uses:

**Description:** Pure thallium is a soft, bluish-white heavy metal that is widely distributed in trace amounts in the earth's crust. It is odorless and tasteless. It can be found in pure form or mixed with other metals in the form of alloys. Thallium exists in two states: thallos and thallic. The thallos state is the more common and stable form.

**Uses:** Thallium is used in the manufacture of electronic devices, switches and closures. It also has limited use in the manufacture of special glasses and for procedures that evaluate heart disease. Until 1972, thallium was used as a rat poison, but was banned because of its potential harm to man. Thallium is no longer produced in the United States.

Fate:

Major releases of thallium to the environment are from processes such as coal burning and smelting, in which thallium is a trace contaminant of the raw materials.

Thallium tends to be sorbed to soils and is relatively stable in the environment. It is not biotransformed in the environment. Direct soil releases are likely to be small, although atmospheric thallium pollution may contribute to soil contamination in the vicinity of thallium emission sources. The atmospheric half-life of suspended thallium particles is unknown.

Thallium exists in water primarily as a monovalent ion (Thallium+) and may precipitate from water as mineral solid phases. However, some thallium compounds are very soluble in water. Thallium may partition from water to soils and sediments. Furthermore, it can be absorbed by micaceous clays in sediments.

Thallium is a nonvolatile heavy metal and if released to the atmosphere may exist as an oxide, hydroxide, sulfate or as the sulfite  $Tl_2S$ . It has been speculated that thallium sulfate will partition into water vapor, thus precipitation may remove thallium from the atmosphere.

Human Health Effects:

**Routes of Entry:** Thallium may enter the body through ingestion of food and drinking of water, and through inhalation of air containing thallium, or by dermal exposure during skin contact with the metal.

Long term exposure to thallium can produce fatty infiltration and necrosis of the liver, nephritis, gastroenteritis, pulmonary edema, degenerative changes in the adrenals, degeneration of peripheral and central nervous system, alopecia, and in some cases death. Loss of vision and

other signs of poisoning have been related to industrial exposure. Temporary hair loss, vomiting, and diarrhea can also occur. Thallium can be fatal from a dose as low as 1 gram.

No data are available on carcinogenic effects on humans or animals.

Environmental Effects:

Thallium in surface water may be bioconcentrated by aquatic organisms. Bioconcentration factors (BCFs) of 18.2 for clams, 11.7 for mussels, and 27-1430 for atlantic salmon have been reported (ATSDR 1990). The maximum BCF for bluegill sunfish was 34.

Thallium is absorbed by plants from soil and enters the terrestrial food chain. It has been demonstrated that thallium could be absorbed from the rhizosphere by the roots of higher plants.

**MANGANESE**  
(CAS NO. 7439-96-5)

Synonyms:

None

Chemistry and Uses:

**Description:** Manganese is a naturally occurring substance found in many types of rock. Pure manganese is silver-colored, but it does not occur in the environment as a pure metal. It is combined with other chemicals such as oxygen, sulfur, and chlorine (ATSDR 1990).

**Uses:** Manganese compounds are used in the production of batteries, as a component of some ceramics, pesticides, and fertilizers and in nutritional supplements.

Fate:

**Releases to the Environment:** The primary sources of manganese releases to air are industrial emissions, combustion of fossil fuels and reentrainment of manganese-containing soils. Air erosion of dusts is also an important atmospheric source of manganese. Manganese is released to water by discharge from industrial facilities, or as leachate from landfills and soil. Land disposal of manganese-containing wastes are the principal source of manganese releases to soil.

Soluble manganese compounds will adsorb to soil and sediments, but this is dependent on cation exchange capacity and organic composition of soil; therefore, adsorption is highly variable. The oxidation state of manganese may be altered by microbial activity.

Concentrations of manganese in groundwater are similar to those in surface water (20-90  $\mu\text{g/L}$ ), although values ranging from 1300 to 9600  $\mu\text{g/L}$  have been reported (ATSDR 1990).

The transport and partitioning of manganese in water is controlled by the solubility of the specific chemical form present and a number of other variables. Divalent manganese predominates in most waters. Manganese may be transported in rivers as suspended sediments. Manganese in water may be significantly bioconcentrated at lower trophic levels.

Elemental and most compounds of manganese have negligible vapor pressures; however, they can exist in air as suspended particulate matter derived from industrial emissions or the erosion of soils. The half-life of airborne particles is usually on the order of days, depending on the size of the particle and atmospheric conditions. Removal by washout may also occur, but is less important than dry deposition.

### Human Health Effects:

Manganese may enter the body primarily through ingestion of food and water and through inhalation.

Chronic manganese poisoning may occur and can result in manganism with central nervous system effects. Symptoms include languor, sleepiness, and weakness in the legs. Manganese psychosis can occur as well. Inhalation of manganese compounds in aerosols or as dusts can cause "metal fume fever."

Manganese maintains a Class D classification by U.S. EPA, as not classifiable as to human carcinogenicity.

### Environmental Effects:

Bioconcentration factors of 2500-6300 have been estimated for phytoplankton, 300-5000 for marine algae, 800-830 for intertidal mussels, and 35-930 for coastal fish. Studies indicate that lower organisms such as algae have larger BCFs than higher organisms, which suggests that biomagnification of manganese in the food chain is not significant.

Manganese is oxidized by microorganisms in soils. Bacteria and microflora can increase the mobility of manganese in coal-waste solids.

HMX  
CAS NO. 2691-41-0

Synonyms:

beta HMX  
cyclotetramethylenetetranitramine  
HW4  
LX 14-0  
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine  
Octogen  
Oktogen  
Tetramethylenetetranitramine  
1,3,5,7-tetrazocine, octahydro-1,3,5,7-tetranitro  
UN 0226

Chemistry and Uses:

Description: HMX is an explosive polynitramine. Information on the description of HMX was limited (NLM, 1992).

Uses: HMX is used in the manufacture of explosives (NLM, 1992).

Fate:

In river water, photolysis is the dominant transformation process. Poor light transmission in lagoon waters inhibited photolysis. Conditions were not favorable in the river or LAAP lagoons for biotransformation. HMX may be persistent in these environments with dilution being the major factor in reducing HMX concentrations. Biotransformation occurred under aerobic and anaerobic conditions in HMX wasteline water, but were not favorable in the river on LAAP lagoon. Half-lives for photolytic transformation in the (Holston) river and the lagoon were 17 days and 7,900 days, respectively (NLM, 1992).

Human Health Effects:

Following a 13 week Fisher Rat study, a NOAEL of 50 mg/kg/day and a LOAEL of 150 mg/kg/day were determined. An RfD of 5E-2 mg/kg/day is established.

Dose-related reductions in weight gain were noted. Following histologic exams, hepatic lesions and other changes were noted (NLM, 1992).

HMX is not classifiable as to human carcinogenicity. No human studies evaluating carcinogenicity were found. No chronic bioassays evaluating carcinogenicity in animals were found.

**Environmental Effects:**

HMX exhibits acute toxicity to aquatic organisms. Mutagenic activity was not exhibited using the Ames test in *Salmonella typhimurium*. The 7-day old fry of the fathead minnow was acutely affected, with an  $LC_{50}$  of 15 mg/L/96-hour (NLM, 1992).

**BENZYL ALCOHOL**  
**CAS NO. 100-51-6**

**Synonyms:**

(Hydroxymethyl) Benzene  
Alpha-hydroxytoluene  
Alpha-toluenol  
Benzal alcohol  
Benzene carbinol  
Benzenemethanol  
Hydroxytoluene  
Phenyl-methanol  
NCI-C06111

Phenolcarbinol  
Phenyl carbinol  
Phenylcarbinol  
Phenylmethanol  
Phenylmethyl alcohol  
Euxyl K 100  
Benzylicium  
Alcohol benzylique

**Chemistry and Uses:**

**Description:** Benzyl alcohol is a water-white liquid with a faint aromatic odor and a sharp burning taste. It is somewhat soluble in water (NLM, 1992).

**Uses:**

Benzyl alcohol is used in the manufacture of other benzyl compounds. It is used as a solvent, in perfumery and flavoring, in shellac, as a preservative in some medications, in cosmetics and other products (NLM, 1992).

**Fate:**

Benzyl alcohol occurs either free or as an ester in oils (i.e. jasmine, castoreum, etc.). It can be released to the environment in the exhaust from gasoline and diesel engines, wastewater emissions during manufacture and use, from leachate in landfills, and also in the use of cosmetics and other products (NLM, 1992).

Exposure to benzyl alcohol occurs by inhalation and ingestion during production or use of products containing benzyl alcohol (NLM, 1992).

If released to the soil, benzyl alcohol displays very high mobility and will readily leach through soil. Microbial degradation may occur. Volatilization from dry soil may be an important fate process, while in moist soils it is insignificant (NLM, 1992).

Benzyl alcohol is expected to undergo microbial degradation under aerobic and anaerobic conditions. It is also biodegraded by biological sewage treatment. Based on Henry's Law Constant ( $3.9 \times 10^{-7}$  atm m<sup>3</sup>/mol @ 25°C), volatilization should not be an important fate process. The half-life from a model river 1 meter (m) deep, flowing at 1m/sec with a wind velocity of 3m/sec is 97 days (NLM, 1992).



Benzyl alcohol in the atmosphere is expected to exist almost entirely in the vapor phase. The vapor phase reaction of benzyl alcohol with photochemically produced hydroxyl radicals gives an estimated half-life of 2 days. Benzyl alcohol may also undergo dissolution into clouds and be removed from the atmosphere by precipitation (NLM, 1992).

#### Human Health Effects:

Exposure to benzyl alcohol may occur by dermal contact, ingestion, and inhalation.

Ingestion of large volumes of benzyl alcohol results in vomiting, diarrhea, and CNS depression. It can cause convulsions followed by paralysis of the respiratory center. It has been used as an anesthetic for minor surgery.

Rats were injected w/450 mg/kg of benzyl alcohol as 20 percent solution in oil for 10 treatments. The initial symptoms were weight depression, but no other pathologic signs of toxicity were noticed (NLM, 1992).

#### Environmental Effects:

An  $LC_{50}$  of 460 mg/L/96-hr was determined for the fathead minnow in a static bioassay in Lake Superior at 18-22°C.

The  $LC_{50}$  for the bluegill Sunfish in a static bioassay at 23°C was 10 ppm/96 hr.

A bioconcentration factor of 4.0 is calculated and implies that bioconcentration in fish and aquatic organisms will not be significant (NLM, 1992).

**1,2-DICHLOROBENZENE**  
**CAS NO. 95-50-1**

**Synonyms:**

AI3-00053  
o-Dichlorobenzene  
Caswee No. 301  
Cloroben  
Dichlorobenzene, ortho, liquid  
O-Dichlor Benzol  
O-Dichlorobenzol  
Dilantin DB  
Dowtherm E

Orthodichlorobenzene  
Orthodichlorobenzol  
NCI-C54944  
EPA Pesticide Chemical Code 059401  
Chloroben

**Chemistry and Uses:**

**Description:** 1,2-Dichlorobenzene is a colorless liquid with a pleasant aromatic odor. It has a vapor pressure of 1.47 mm Hg at 25°C.

**Uses:** 1,2-Dichlorobenzene is used as a solvent for waxes, resins, tars, rubber, oils, asphalt, etc., an insecticide for termites, a degreasing agent for metals, leather, etc., a magnetic coil coolant, and as a component of rust-proofing mixtures (NLM, 1992).

**Fate:**

1,2-Dichlorobenzene is not known to occur in nature. It is released to the environment as discharge from wastewater deodorizing, and from manufacture and use as solvents. 1,2-DCB is released to the atmosphere by solvent applications. Primary exposure to 1,2-DCB is by inhalation, dermal contact, and ingestion of contaminated food and water (NLM, 1992).

1,2-DCB can moderately to tightly be absorbed to soil. Leaching can occur. Volatilization may be an important transport mechanism, but it may be lessened due to its absorption or leaching potential. 1,2-DCB will slowly biodegrade in soil under aerobic conditions. Hydrolysis oxidation or direct photolysis is not expected (NLM, 1992).

Adsorption to sediment is a major fate process. 1,2-DCB is volatile from water with an estimated half-life of 4.4 hours. 1,2-DCB may biodegrade in aerobic water, after microbial adaptation, but will not biodegrade under anaerobic conditions which may exist in various waters, etc. Bioaccumulation may be an important fate process based on detection of 1,2-DCB in trout in Lake Ontario (NLM, 1992).

1,2-DCB will exist in the atmosphere in the vapor phase. The half-life for the reaction of 1,2-DCB with photochemically produced hydroxyl radicals is 24 days. Direct photolysis is not expected to be important. Wash-out of 1,2-DCB may be a possible removal source from the atmosphere (NLM, 1992).

#### Human Health Effects:

Routes of exposure are inhalation of contaminated air and dermal contact. Occupational exposure will be through its manufacture and use as a chemical solvent. General exposure will occur through consumption of drinking water or contaminated fish (NLM, 1992).

When 1,2-DCB is applied locally, intense erythema and edema result. Vapors and sprays are irritating to eyes, nose, and throat, but disappear quickly. If swallowed, pain in the stomach, nausea, vomiting, and diarrhea will occur. The liver and kidney may be damaged. Toxicological effects begin primarily with liver and, secondarily, the kidneys. Exposure to high concentrations in short time periods result in CNS depression.

In rat studies, the maximum tolerated dose by gavage for 5 days/week for 28 weeks is 19-190 mg/kg body wt./day. Neither teratogenic or fetotoxic effects were determined after inhalation of 400 ppm. Oral exposure to 1,2-DCA resulted in degeneration and necrosis in the liver, lymphocyte depletion in the spleen, etc. The NOAEL is 85.7 mg/kg/day (NLM < 1992).

1,2-DCB is Class D, not classifiable as to human carcinogenicity. Animal (rats) data showed evidence of positive and negative trends for carcinogenic responses.

#### Environmental Effects:

The  $LC_{50}$  of 500 mg/L/96 hour was hazardous to the fathead minnow.

Bioconcentration factors of 66 (for bluegill sunfish) to 560 were determined.

Acute and chronic toxicity to freshwater aquatic life are at concentrations of 1,120 and 763  $\mu\text{g/L}$ , respectively. Toxicity to saltwater aquatic life is as low as 1,970  $\mu\text{g/L}$ .

**1,3-DICHLOROBENZENE**  
**CAS NO. 541-73-1**

**Synonyms:**

m-Dichlorobenzene  
m-Dichlorobenzol  
m-Phenylene Dichloride

Meta-Dichlorobenzene  
M-DCB  
1,3-DCB

**Chemistry and Uses:**

**Description:** 1,3-Dichlorobenzene is a colorless, combustible liquid. It has a vapor pressure of 2.3 mm Hg at 25°C. 1,3-DCB is soluble in alcohol, ether, acetone and benzene and is insoluble in water.

**Uses:** 1,3-Dichlorobenzene is used as a fumigant and an insecticide.

**Fate:**

1,3-Dichlorobenzene does not occur in nature. The major source of release is chemical waste dump leachate and direct chemical manufacturing effluents. As a fumigant is released to the atmosphere and is also released as a chemical intermediate or solvent. Exposure to 1,3-DCB occurs through inhalation of contaminated air or consumption of contaminated drinking water and food.

1,3-DCB can be moderately to tightly absorbed to soil. Leaching can occur and volatilization may be an important transport process. 1,3-DCB will slowly biodegrade in aerobic conditions. Hydrolysis, oxidation, or direct photolysis are not expected to occur. Based on the vapor pressure (2.3 mm Hg@ 25°C), 1,3-DCB is expected to evaporate at a significant rate from dry surfaces (NLM, 1992).

Adsorption to sediment is a major transport process. 1,3-DCB is volatile from water with an estimated half-life of 4.1 hours from a model river. Adsorption to sediment will attenuate volatilization. It may biodegrade in aerobic water after microbial degradation, but is not expected to biodegrade in anaerobic conditions. BCF values of 89-740 confirmed a level of bioaccumulation. Hydrolysis, oxidation, and direct photolysis are not expected to be important (NLM, 1992).

1,3-DCB will exist in the vapor-phase in the atmosphere. The estimated half-life for 1,3-DCB in reaction with photochemically produced hydroxyl radicals is 14 days. Removal of 1,3-DCB in the atmosphere is possible by wash-out.

### Human Health Effects:

General exposure to 1,3-DCB occurs through consumption of contaminated drinking water and food (i.e., fish) in the vicinity of effluent discharges. Occupational exposure (inhalation and dermal contact) occur during its manufacture or use.

Vapors and sprays are irritating to the eyes, nose and throat, but effects disappear quickly. If swallowed, stomach pain, nausea, vomiting and diarrhea occur. Liver and kidney may be damaged.

1,3-DCB is not classifiable as to human carcinogenicity based on no human data, no animal data, and limited genetic data.

### Environmental Effects

Chronic toxicities for the 32-33 day embryo through juvenile fathead minnow estimated in ranges between the highest and lowest NOAEL were 1,000 to 2,300  $\mu\text{g/L}$ . Tissue concentrations for NOAEL and LOAEL were 120-160  $\mu\text{g/L}$ . The  $\text{LC}_{50}$  for the fathead juvenile minnow was 7800  $\mu\text{g/L}$ .

A bioconcentration factor of 89 was determined for the bluegill sunfish. The  $\text{LC}_{50}$  for the bluegill sunfish and the fathead juvenile minnow are 5.02 and 12.7  $\text{mg/L/96 hour}$ , respectively.

**1,4-DICHLOROBENZENE**  
**CAS NO. 106-46-7**

**Synonyms:**

1,4-Dichloorbenzeen  
1,4-Dichlor-benzol  
1,4-Dichlorobenzene  
p-Dichlorobenzene  
Dichlorobenzene, para, solid  
p-chlorophenyl chloride  
p-Dichloorbenzeen (Dutch)  
p-Dichlorobenzol  
p-Dichlorobenzene (Italian)  
PDB  
Paradichlorobenzene  
Paradichlorobenzol  
NCI-C54955  
Caswell No. 632  
A13-0050

EPA Pesticide Chemical Code 06/501  
Paradichlorobenzol  
Paramoth  
Di-chloricide  
Paradi  
Rersia - Perazol  
Santochlor  
Paradow  
Evofa  
Parazene

**Chemistry and Uses:**

**Description:** 1,4-Dichlorobenzene is a white solid (in the form of crystal prisms) with a sweet taste and a mothball-like odor. When exposed to air, it becomes a vapor. 1,4-Dichlorobenzene has a vapor pressure of 0.6 mm Hg at 20°C. It does not burn easily and is not soluble in water.

**Uses:** 1,4-Dichlorobenzene is used as a space deodorant for toilets, refuse containers and as a fumigant for moth, mold, and mildew control. Some 1,4-Dichlorobenzene was used in PPS resins and as an intermediate in the production of other chemicals. It is also used in control of certain tree-boring insects and mold in tobacco seeds (NLM, 1992).

**Fate:**

There are no known natural sources of 1,4-dichlorobenzene. Other releases are from the manufacture or during the production of 1,4-dichlorobenzene. Concentrations have been found in leachate from industrial and municipal wastes. Releases in soil are due to industrial waste in landfills (NLM, 1992).

1,4-Dichlorobenzene can be moderately or tightly absorbed to soil. Leaching has been reported to occur. Volatilization may be important; however, it may be attenuated by adsorption and leaching. It slowly biodegrades under aerobic conditions (NLM, 1992).

1,4-Dichlorobenzene is volatile from water with a half-life of 4.3 hours. Volatilization is a major removal process. Adsorption to sediment in water will attenuate volatilization. 1,4-Dichlorobenzene may biodegrade in aerobic water after microbial adaptation. It is not expected

to biodegrade under anaerobic conditions. Experimental BCFs are <1,000 which suggests bioconcentration will not occur (NLM, 1992).

### Human Health Effects:

General population exposure is through oral consumption of drinking water and food (particularly fish). Exposure may also occur through inhalation of contaminated air. Occupational exposure occurs during the manufacture and use of 1,4-dichlorobenzene.

Solid particles, vapor, or fumes are painful to the eyes and nose. The vapor is painful to most people at concentrations of 50 and 80 ppm; discomfort is severe at 160 ppm. Above 160 ppm, vapors are intolerable. Prolonged exposure may cause weakness, dizziness, weight loss, and liver damage (NLM, 1992).

1,4-Dichlorobenzene may be absorbed through the lungs, gastrointestinal tract, and the skin.

In rats, exposure 5 days/week, 4 hours/day from few to 69 times, at 798 ppm caused tremors, weakness, loss of weight, eye irritation, and swelling of epithelium in kidneys. The NOAEL of 18.8 was observed in rats after 6 months exposure 5 days/week. The LOAEL is 188 and 376 for hepatic and renal affects, respectively. An LD<sub>50</sub> in male adult rats was 3863 mg/kg, and in females the LC<sub>50</sub> was 3790 mg/kg (NLM, 1992).

No data were available on the carcinogenicity in humans. An inhalation study in rats did not result in cancer; however, a 2-year oral studied resulted in renal cancer and a 2-year study in mice resulted in liver cancer (ASTDR, 1992).

### Environmental Effects

Acute and chronic toxicity to freshwater aquatic life are at concentrations of 1,120 and 763 µg/L, respectively. Acute toxicity to saltwater organisms is 1,970 µg/L.

A bioconcentration factor of 60 was determined for bluegill sunfish in a 28-day continuous flow system. In a 4-day static test the bioconcentration factor for rainbow trout was 214.

In LC<sub>50</sub> for the fathead minnow is 33.7 mg/L/96 hour.

**2,4-DIMETHYPHENOL**  
**CAS NO. 105-67-9**

**Synonyms:**

1-Hydroxy-2,4-Dimethylbenzene  
2,4-Xylenol  
4,6-Dimethylphenol  
4-Hydroxy-1,3-Dimethylbenzene  
2,4-Dimethyl-1-Hydroxy-Benzene  
m-Xylenol  
As-m-Xylenol  
Caswell No 907A  
EPA Pesticide Chemical Code 086804  
AI3-17612  
Bulk Lysol Brand Disinfectant  
Brand Lysol Disinfectant  
Bacticin  
Gallex  
Du Cor Concentrated Fly Insecticide  
Gable - Tite Dar Creosote (Creota)  
Gable - Tite Light Creosote

**Chemistry and Uses:**

**Description:** 2,4-Dimethylphenol is a white, crystalline solid. It is very soluble in most organics and only slightly soluble in water. It has a vapor pressure of 0.098 mmHg at 25°C.

**Uses:** 2,4-Dimethylphenol is used as a disinfectant, bactericide/germicide, sanitizer, and fungicide. It is also used in solvents, pharmaceuticals; plasticizers; rubber chemicals; additives to lubricants and gasolines (NLM, 1992).

**Fate:**

2,4-Dimethylphenol exists as a naturally occurring constituents of some plants such as tea, tobacco, marijuana, and the Siberian pine. It may also be emitted as fugitive emissions and in wastewater during coal processing and coal tar refining. It is also released in asphalt and roadway runoff and in domestic sewage. Exposure to 2,4-dimethylphenol is primarily by dermal contact (NLM, 1992).

If spilled on soil, 2,4-dimethylphenol would absorb moderately to soil, based on a KOC of 425. Degradation occurred in 4 days in a hard, carbonaceous woody chernozem loam at 19°C (NLM, 1992).

2,4-Dimethylphenol may absorb moderately to sediment and will readily biodegrade. The half-life should be less than several days in humic water due to photooxidation. Photolysis may occur in clear surface waters. Anaerobic degradation in sewage sludge digestion occurred in



groundwater. 2,4-Dimethylphenol has an absorption band which extends  $> 320$  nm and is a candidate for photolysis. It will react with hydroxyl radicals with an estimated reaction half-life of 8 hours. Volatilization is not a significant transport process (NLM, 1992).

Vapor phase 2,4-dimethylphenol should degrade by reaction with photochemically produced hydroxyl radicals. Scavenging by rain will be an effective removal process reflected by high concentrations in rain water (NLM, 1992).

#### Human Health Effects:

The primary route of entry is dermal, by occupational. General public exposure is by use of commercial products containing 2,4-dimethylphenol (NLM, 1992).

2,4-Dimethylphenol is toxic by ingestion and skin absorption. Critical effects include lethargy, prostration, ataxia, and hematological changes. An oral reference dose of  $2 \times 10^{-2}$  mg/kg/day was determined. The NOAEL and LOAEL was 50 and 250 mg/Kg/day, respectively.

Limited data on the effects of 2,4-dimethylphenol were found.

Dimethylphenol isomers produced necrosis when applied in a molten state to rat skin. 2,4-Dimethylphenol was lethal with an  $LD_{50}$  of 1,040 mg/kg (NLM, 1992).

2,4-Dimethylphenol appears to be a topical carcinogen, but its role as a primary cancer-producing agent is uncertain. A 10percent application of 2,4-dimethylphenol was applied (with no initiator) to mice for 20 weeks. The result was 31percent developed papillomas and no carcinomas were observed, but after 24 weeks 12percent developed carcinomas (NLM, 1992).

#### Environmental Effects:

The bioconcentration factor of bluegill sunfish was 150 with a duration of 28 days. Based on this factor, 2,4-dimethylphenol has the possibility to bioaccumulate. The dermal  $LD_{50}$  for rats is 1,040 mg/kg. The  $LC_{50}$  for the fathead minnow is 17 mg/L in a 96-hour flow through bioassay.

**PHENOL**  
**CAS NO.108-95-2**

**Synonyms:**

Acide Carbolique (French)  
Benzenol  
Carbolic Acid  
Carbolsaure (German)  
Fenol (Dutch, Polish)  
Fenolo (Italian)  
Hydroxybenzene  
Monohydroxybenzene  
Monophenol  
NCI-C50124  
Oxybenzene  
Phenic Acid  
Phenole (German)  
Phenyl Alcohol  
Phenyl Hydrate  
Phenyl Hydroxide  
Phenylic Acid  
Phenylic Alcohol  
Izal  
Caswell #649

**Chemistry and Uses:**

**Description:** Phenol is a colorless to light pink, interlaced or needle-shaped crystal or a light pink crystalline mass. When pure, it is devoid of odor of cresol, but retains a distinct aromatic odor which is not disagreeable. Phenol has a sharp burning taste and when in weak solution it has a sweet taste (NLM, 1992).

**Uses:** Phenol is used as a general disinfectant in solution or mixed with slaked lime for toilets, stables, cesspools, floors, drains. It also used in the manufacture of colorless or light-colored artificial resins, many medical and industrial organic compounds and dyes, and is a reagent in chemical analysis (NLM, 1992).

**Fate:**

If phenol is released to soil, it will biodegrade in the soil and this degradation will be rapid (2-5 days) and will also occur in subsurface soils. Degradation will be much slower under anaerobic subsurface conditions. Despite its high solubility and poor absorption in soil, biodegradation is sufficiently so rapid that most groundwater is generally free of this pollutant. If released to water, the primary removal process of it will be biodegradation, which will generally be rapid, although degradation rates are slower under anaerobic conditions.

If released to the atmosphere, phenol will exist predominantly in the vapor phase. Phenol absorbs light in the region, 290-330 nm, and there might directly photodegrade. Estimated half-life by reaction with hydroxyl radicals in air is 0.61 days (NLM, 1992).

#### Human Health Effects:

The U.S. EPA established RfD for Phenol is  $6 \times 10^{-1}$  mg/kg/day. Phenol is classified as D; not classifiable as to human carcinogenicity. The NOAEL and LOAEL is 60 and 120 mg/kg/day, respectively (NLM, 1992).

Both oral ingestion and extensive application to the skin can cause systemic toxicity manifested as transient CNS stimulation followed by CNS and cardiovascular depression; death may result. Ingestion of 1 gram of phenol is lethal in man. Chronic systemic absorption of phenol has been observed to cause gray coloration of the sclera with brown spots near insertion of rectus muscle tendons, associated with blue or brown discoloration of tendons over knuckles or hands. This is a form of ochronosis, also known as carbolochronosis (NLM, 1992).

Symptoms of toxicity after ingestion include burning pain in mouth and throat, lesions in mouth, esophagus, and stomach. Abdominal pain, vomiting and bloody diarrhea, pallor, sweating, weakness, headache, dizziness, tinnitus, shock, weak irregular pulse, hypotension, shallow respirations, cyanosis, and profound fall in body temperature also are known to occur. Death from respiratory circulatory or cardiac failure may occur. If spilled on skin, pain is followed by numbness. The skin becomes blanched, and a dry opaque eschar forms over the burn. Phenol is toxic if absorbed and may result in death even if the exposed area is as small as that of a hand or forearm. Oral ingestion can result in mucocutaneous and gastrointestinal corrosion. Death can also occur from dermal application of phenol (NLM, 1992).

Fatal neonatal hyperbilirubinemia from inhalation of phenolic vapors has occurred in poorly ventilated nurseries. On human eyes, phenol renders the conjunctiva chemotic, and the cornea white and hypesthetic. Sometimes blindness and loss of the eye can occur (NLM, 1992).

#### Environmental Effects:

Phenol does not significantly bioconcentrate in aquatic organisms. Nevertheless, it is toxic to fish and has a nearly unique quality of tainting the taste of fish if present in the marine environment. The LD<sub>50</sub> for phenol is .53, 0.1, and 0.5 g/kg for the rat, cat and dog, respectively. TDLo for minnows is 30 minutes, while the LC<sub>50</sub>s for golden shiner and goldfish were 35-129 and 60-200 mg/L in a static bioassay (NLM, 1992).

2-METHYL-4,6-DINITROPHENOL  
CAS NO. 534-52-1

Synonyms:

4,6-DINITRO-O-CRESOL  
2,4-DINITRO-O-CRESOL  
3,5-DINITRO-2-HYDROXYTOLUENE  
4,6-DINITRO-O-CRESOLO (Italian)  
4,6-DINITRO-O-KRESOL (Czech)  
6-METHYL-2,4-DINITRO-CRESOL  
DINITRO-O-CRESOL  
DINITRO-CRESOL  
DINOC  
DNOC  
DNOK (Czech)  
DWUNITRO-O-KRESOL (Polish)  
LE DINITRO-CRESOL-4,6 (French)  
TOLUENE, 3,5-DINITRO-2-HYDROXY-  
o-cresol, 4,6-dinitro-  
ELGETOL  
ANTINONIN  
CHEMSECT DNOC  
DEKRYLIL  
DETAL  
DINITROL  
EFFUSAN 3346  
ELGETOL 30  
K III  
K IV  
SELINON  
DINITROSOL  
DINITRO  
NITRADOR  
SINOX  
TRIFOCIDE  
TRIFRINA  
ANTINNONIN  
ARBOROL  
CAPSINE  
DEGRASSAN  
DILLEX  
DINTRODENDTROXAL  
DINURANIA  
DN  
ELIPOL  
ENT 154

EXTRAR  
HEDOLIT  
KREOZAN  
KREZOTOL  
SANDOLIN  
NITROFAN  
PROKARBOL  
RAFEX  
RAFEX 5  
RAPHALOX  
SANDOLIN  
SINOX  
WINTERWASH

Chemistry and Uses:

Description: 2-Methyl-4,6-dinitrophenol is an odorless yellow solid, which is slightly soluble in water, soluble in alcohol, acetone and ether.

Uses: 2-Methyl-4,6-dinitrophenol is a contact herbicide used for the control of broad leaved weeds. It is also used as a contact insecticide and a dormant spray insecticide, especially for fruit trees or on waste ground, to kill locusts and other insects.

Fate:

2-Methyl-4,6-dinitrophenol usually disappears from soil within a few weeks to 2 months when applied at normal pesticidal rates. Biodegradation is probably the main removal process from agricultural soils. It has medium to low soil mobility, with the greatest mobility expected in coarse-textured sandy soils and the least mobility in fine textured clay and organic soils. Aquatic hydrolysis, volatilization, bioconcentration, and adsorption to sediments are not expected to be important fate processes. Direct photolysis may occur since it absorbs light in the environmentally important range. The half-life for photooxidation via peroxy radicals has been estimated to be 58 days. 2-Methyl-4,6-dinitrophenol may exist in both the vapor phase and adsorbed to the particulate phase in the atmosphere. In the vapor phase, 2-methyl-4,6-dinitrophenol will react photochemically with photochemically produced hydroxyl radicals at an estimated half-life rate of 8 hours. Particulate phase 2-methyl-4,6-dinitrophenol will be susceptible to wet and dry deposition. Wet deposition is not expected to be important. Terrestrial, microbial, and photochemical decomposition; volatilization; movement; organism uptake; and adsorption are the principal factors affecting the fate and behavior of pesticides in soil and water systems (NLM, 1992).

### Human Health Effects:

Acute poisoning in man from dermal skin absorption, oral ingestion, or from inhalation of aerosols includes nausea, gastric upset, restlessness, sensation of heat, flushed skin, sweating, rapid respiration, tachycardia, fever, cyanosis, and finally collapse and coma. Chronic exposure to this chemical may also produce fatigue, restlessness, excessive sweating, unusual thirst, and loss of weight. A yellow staining of the conjunctiva has been noted and cataract formation is another possible sequela of chronic exposure. It is possible for glaucoma to develop secondary to the cataracts. Death may result from either slow or acute poisoning (NLM, 1992).

### Toxicity:

No information is available from U.S. EPA on the characterization of 2-methyl-4,6-dinitrophenol as a carcinogen, nor have any Reference Doses or Slope Factors been determined.

The BCF estimated for 2-methyl-4,6-dinitrophenol is 52 and 40, based on regression-derived equations. It has been suggested that 4,-6-dinitro-o-cresol may not bioaccumulate because of its marked toxicity.

The LD<sub>50</sub> for 5-7 month old mallards from an oral dose was 22.7 mg/kg. An EC<sub>50</sub> of 145 µg/L/48 hour was determined for first instars of Daphnia pulex. LC<sub>50</sub>s of 1100, 320, 360 and 66 µg/L/96 hour were found for the scud (Gammarus fasciatus), Pteronarcys, bluegill (Lepomis microlophus), and rainbow trout (Salmo gairdneri), respectively (NLM, 1992).

NITRATE  
CAS NO. 14797-55-8

Synonyms:

Collo-Bo  
Kalii Nitras  
Kaliumnitrat  
Niter  
Nitrate of Potash  
Nitre

Nitric Acid Potassium Salt  
Saltpeter

Chemistry and Uses:

Description: Nitrate is an odorless, white, granular or crystalline powder with a cooling, saline pungent taste. It is slightly soluble in water and is insoluble in ether (NLM, 1992).

Uses: Nitrate is used in fireworks; fluxes; pickling of meat; manufacture of glass, matches, blasting and gun powder. It is also used as a fertilizer and medically as a diuretic (NLM, 1992).

Fate:

Nitrate is present in well water contaminated by runoff from nitrogen fertilizers, decaying matter, or sewage treatment plants. No data were found on the fate, biodegradation, or transformation processes of nitrate (NLM, 1992).

Human Health Effects:

The main route of exposure for nitrate is by ingestion. Nitrate is most rapidly absorbed and excreted unchanged. In some instances, if not absorbed, nitrate is reduced to nitrite in saliva. Excretion is primarily through the kidney.

Ingestion of large quantities may cause violent gastroenteritis, while prolonged exposure to small amounts may produce anemia, methhemoglobinemia, and nephritis. Symptoms from nitrate exposure include: fall in blood pressure, a roaring sound in ears, headaches, and visual disturbances, nausea and vomiting, followed by collapse, coma and clonic convulsions. Death may result due to circulatory failure. The lethal dose for an adult ranges from 54 to 462 mg/kg (NLM, 1992).

Acute toxicity is a result of the reduction of nitrate, which occurs in the stomach and saliva. Nitrite oxidizes hemoglobin to methhemoglobin which is not an oxygen carrier to the tissues, anoxia and death may occur. The toxic dose varies greatly; 15 to 30 grams may be fatal, but larger doses have been taken without serious effect (NLM, 1992).

In animals, after nitrate ingestion, abdominal pain and diarrhea are seen, along with muscular weakness, convulsions, increased heart rate, and in severe cases, progressive cyanosis, leading

to coma and death. In experimental horses, an oral dose of 1,000 mg/kg of body weight caused illness, not death.

The NOAEL and LOAEL are 1.6 mg/kg/day and 1.8 - 3.2 mg/kg/day, respectively. An oral reference dose of 1.6 + 0 mg/kg/day has been established. A reproductive/developmental NOAEL of 41 mg/kg/day for rats and rabbits was identified (NLM, 1992).

No data were available on human carcinogenicity (NLM, 1992).

#### Environmental Effects:

Data on the aquatic toxicity of nitrate were not found, and only limited data on terrestrial animals were found.

The acute oral LD<sub>50</sub> is 1000 mg/kg in sheep. The oral LD<sub>50</sub> of 1.166 g anion/kg for rabbits (NLM, 1992).



FLUORIDE  
CAS NO. 16984-48-8

Synonyms:

Alcoa Sodium Fluoride  
Antibulit  
Cavi-Trol  
Credo  
Disodium Difluoride  
Fl-Tabs  
FDA 0101  
Floridine  
Florocid  
Flozenges  
Fluor-O-Kote  
Fluoraday  
Fluorid Sodny (Czech)  
Fluorident  
Fluorigard  
Fluorineed  
Fluorinse  
Fluoritab  
Fluorol  
Fluorure De Sodium (French)

Flura Drops  
Flucare  
Flursol  
Frungol B  
Gleem  
Iradicave  
Karidium  
Lemoflur  
Luride  
Nafpak  
Natrium Fluoride  
NCI-C55221  
Ossalin  
Ossin  
Pergantene  
Phos-Fluor  
Roach Salt  
Sodium Fluoride Cyclic Dimer  
Sodium Fluorure  
Sodium Hydrofluoride  
Sodium Monofluoride  
T-Fluoride  
Thera-Flur  
Thera-flur-N  
Trisodium Trifluoride  
Villiamite  
Zymafluor  
Chemifluor  
Luride SF

### Chemistry and Uses:

**Description:** Fluoride is a white crystalline powder with a salty taste. It is soluble in water and only slightly soluble in alcohol.

**Uses:** Fluoride is used in electroplating; for disinfection in breweries and distillery apparatus; in dental labs; as a fungicide, rodenticide, and glass manufacturer; as a fluoridation agent in drinking water; and in other processes. It is also used orally to increase bone density and relieve bone pain in various bone diseases (NLM, 1992).

### Fate:

The natural concentration of fluoride in groundwater depends on numerous factors. It ranks thirteenth in order of abundance in the earth's crust. Fluoride rarely occurs in the elementary state; instead it is found in the ionic form or as a variety of organic and inorganic fluorides. It is produced from factories, processing fluorine containing ores. Exposure to fluoride occurs through inhalation of dust and ingestion of contaminated drinking water (NLM, 1992).

The natural concentration of fluoride in groundwater is dependent on the geology, chemical and physical characteristics of the water-supply area, the consistency of soil, porosity of rocks, the pH, temperature, and the action of other elements (NLM, 1992).

### Human Health Effects:

Routes of exposure to fluoride include inhalation, ingestion, and dermal contact. Fluorides are absorbed through the gastrointestinal tract, the lungs and skin contact, with the gastrointestinal tract being the major site of absorption. Fluoride is almost 100percent absorbed through the stomach and small intestine. Following ingestion of fluoride, 97percent is absorbed and distributed throughout the body by the blood. Excessive exposure to fluoride will result in retention in the bone (NLM, 1992).

Irritation of the skin, eyes, and respiratory tract occurs from dust and inhalation. Ingestion of fluoride causes a salty taste, salivation, and nausea. Large doses lead to burning and crampy abdominal pain, vomiting and diarrhea, dehydration and thirst, CNS depression, shock, then arrhythmia, which leads to cardiac arrest (NLM, 1992).

Acute poisoning may result in death by respiratory paralysis. In the use of oral fluoride supplements in the prevention of tooth decay showed no adverse effects unless huge amounts are ingested. The lethal dose for a 70 kg man has been cited with a range of 5 to 10 grams (NLM, 1992).

Chronic ingestion of excessive amounts of fluoride results in osteosclerosis and mottled enamel, increased density and clarification of bone. When administered at 6 mg/day, fluorosis resulted. Symptoms include brittleness of bone, weight loss, anemia, and general ill health (NLM, 1992).

Symptoms of acute poisoning in animals include: hemorrhages, congestion and edema in various organs, muscle tremors, weakness, salivation, convulsions, coma, and death due to respiratory

and cardiac failure. Chronic poisoning results in lameness, painful gait, anorexia, rough coat, etc., mottling and loss of teeth. Following IV administration of 35 mg/kg body weight in rats, calcium contents in the renal cortex and medulla increased 33 and 10 times, respectively.

Fish exposed to poisonous amounts of fluoride experience loss of weight, apathy, violent movement, loss of equilibrium, and finally death.

Carcinogenicity in humans is not classifiable based on limited data. In groups of mice (2-9 months old) that were given 10.0 mg/L of fluoride, 63percent died of mammary gland carcinomas (NLM, 1992).

#### Environmental Effects:

The LD<sub>50</sub>s for rats administered orally, intravenously, and intraperitoneally is 32.0 mg/kg, 11.8 mg/kg, and 24 mg/kg, respectively (NLM, 1992).

PCB 1262  
CAS NO. 37324-23-5

Synonyms:

Chlorinated diphenyl  
PCB  
Aroclor 1262  
Caswell No. 672A  
EPA Pesticide Chemical Code 017801

Chemistry and Uses:

Limited information on the specific PCB 1262 was found. The following profile details PCB as a group.

Description: PCB 1262 is a polychlorinated biphenyl mixture with 61.5-62.5 percent chlorine. It is a sticky resin with little to no odor. Solubility in water is extremely low (ASTDR, 1992).

Uses: PCB is not naturally occurring in nature. It is produced and restricted to use in non-totally enclosed manner in hydraulic systems, in microscopy as mounting medium and in small quantities for research and development (as enzyme inducers) (NLM, 1992).

Fate:

PCBs (Aroclors) are no longer produced or used in the manufacture of new products. Releases to the air occur in the redistribution of compounds already present in soil and water. They are also released from transformers and capacitors found in disposal sites, incineration of PCB-containing wastes, and illegal or improper disposal of PCB. In surface water, PCB is released during the environmental cycling process. In soil, the deposition of atmospheric PCB from the environmental cycling process is the major source of PCB in the soil (ASTDR, 1992). Exposure to PCB is through ingestion of food and water, along with inhalation of contaminated air. Dermal exposure is a likely route for workers handling PCB-containing equipment (NLM, 1992).

PCB in soil is resistant to biodegradation, although this is the ultimate degradation process. The low water solubility and high octanol-water partition coefficients demonstrate strong absorption to soil and sediment and indicate that leaching should not occur under most conditions (ASTDR, 1992). In the presence of organic solvents, PCB will leach quite significantly in soil. Volatilization rates in soils will be low for areas with high chlorination. The half-life for the more highly chlorinated PCBs is >60 - >150 years, taking into account environmental fate mechanisms (NLM, 1992).

PCBs in the atmosphere occur primarily in the vapor-phase state. The tendency of PCBs to absorb to airborne particulates will increase as the degree of chlorination increases. Physical removal of PCB in the atmosphere is accomplished by wet and dry deposition. These emissions may be transported long distances from their sources. The dominant transformation process may

be the photochemical reaction of PCB with the hydroxyl radical. A half-life ranges from 12.9 days (monochlorobiphenyl) to 1.31 years (heptachlorobiphenyl) [NLM, 1992].

In water, absorption to sediment and organic matter is the major fate process for PCBs. Concentrations in sediment are greater than in the water column, indicating that sediments act as a reservoir from which PCBs may be released slowly over a long period of time. Redistribution from aquatic sediments will be significant for PCBs in the top layers of sediments.

Volatilization of PCBs is an important transport process. Adsorption to sediments will decrease volatilization rate. Even though the volatilization is low, the total loss over time may be significant due to the persistence and stability of PCBs. Aquatic hydrolysis and oxidation are not significant processes for PCBs in the aquatic environment (NLM, 1992).

PCBs are highly lipophilic and bioconcentrate in tissue. The bioconcentration factor of fat in humans is 175 (wet weight basis). BCFs in fish, shrimp, and oysters range from 26,000 to 660,000. For the fathed minnow, BCFs range from 43,000-200,000. The BCF in aquatic animals may depend on the water zone where they reside. Due to airborne PCBs, the surface layers contain higher concentrations of PCBs. Since concentrations in sediments are also higher than water, bottom feeders will have higher concentrations of PCB. Evidence that PCB will biomagnify in the food chain is indicated by the levels in higher tropic levels in aquatic organisms and in fish-consuming birds and seals (ASTDR, 1992).

#### Human Health Effects:

Environmental contamination may be a significant source of human exposure. Likely routes of entry are ingestion through water and food, while inhalation and dermal contact are significant in occupational exposures. Exposure through consumption of contaminated fish may be important.

PCBs are readily absorbed through the gastrointestinal tract, respiratory system, and the skin. They may initially concentrate in the liver, blood and muscle, while long-term storage in mammals is in adipose tissue and skin. PCBs are readily metabolized and are excreted in urine and bile. Urine excretion is most prominent for least chlorinated, while bile is a significant route for highly chlorinated PCBs. Highly chlorinated PCBs accumulate almost indefinitely. Excretion also occurs through breast milk and through the placenta (NLM, 1992).

Symptoms associated with exposure to PCBs are abdominal pain, anorexia, nausea, vomiting, jaundice and in rare cases, coma and death. Neurological symptoms include headaches, dizziness, depression, nervousness, fatigue, weight loss, muscle, and joint pain. Responses from occupational exposure to PCBs include chloracne, hyperpigmentation of skin, conjunctivitis, subcutaneous edema, edema of the eyelids, decrease in red blood cells, discoloration of fingernails, and thickening of the skin. PCB are liver toxins and may cause peripheral neuropathy in man.

A correlation between occupationally exposed mothers and PCB levels in breast milk was determined. Nursing infants had blood PCB levels that were determined to be higher than the mothers. Developmental abnormalities were also observed in these infants.

The first documented incident resulting in acute toxicosis was from ingestion of a rice (Japanese) oil contaminated with industrial oil containing PCBs. The amount consumed ranged from 0.5 to 2 grams (NLM, 1993).

Information on general population exposure was limited, while occupational exposure studies were more prevalent.

PCB exposure in animals has been found to increase synthesis; hepatic content and excretion of porphyrins. PCBs have been found (as in humans) to cross the placental barrier and are excreted in mother's milk. The most consistent pathological changes in mammals occur in the liver. In rats, rabbits, and guinea pigs after injection and dermal application, fatty deposits were noted. After repeated exposure in rats and an increase in liver weight was observed. PCBs were also shown to inhibit the growth of experimental tumors in rats. An oral LD<sub>50</sub> of 1,010 for rats was observed. A NOAEL of 0.5 mg/kg/day for acute oral exposure was determined (NLM, 1992).

PCB is classified as a B2 human carcinogen. The basis for classification is hepatocellular carcinomas in three strains of rats and two strains of mice and inadequate yet suggestive evidence of excess risk of liver cancer in humans by ingestion and inhalation or dermal contact.

The data for carcinogenicity is inadequate due to confounding exposures and lack of exposure quantification. A significant increase in malignant melanomas was reported at a petrochemical plant, but the study was unable to report a quantified exposure level or to account for other carcinogens.

A TWA daily dose of 3.45 mg/kg/day was observed, and the oral slope factor is 7.7 mg/kg/day.

Data on the carcinogenicity in animals are sufficient. Benign and malignant liver cell tumors, lymphomas and leukemia, and carcinomas of the gastrointestinal tract were observed. In a long-term bioassay with Aroclor 1260, females Sherman rats developed hepatocellular carcinomas after administration of 100 ppm PCB for 630 days (NLM, 1992).

In another study, Sprague-Dawley rats (70 male/70 female) were fed PCBs in corn oil at 100 ppm for 16 months, followed by a 50 ppm diet for 8 months, then a basal diet for 5 months. Female rats that survived the 18 months exhibited 91 percent incidence of hepatocellular carcinoma and 4 percent neoplastic nodules. Incidences in male rats were lower. Morphology studies of these rats indicate sequential progression of liver lesions to hepatocellular carcinomas (NLM, 1992).

#### Environmental Effects:

The eggs of three seabird species (double-crested cormorant, storm-petrel, and the Atlantic puffin) were examined at sites in eastern Canada. PCB residues were highest in the double-crested cormorant; however, results and levels were not listed (NLM, 1992).

Channel catfish exposed to PCBs in a highly industrial area and adjacent hazardous waste sites in Louisiana were examined for PCB concentration. When compared to a reference fish (devoid of exposure to PCB), the channel catfish exhibited elevated PCB congener concentrations in fatty tissue (NLM, 1992).

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**APPENDIX E**

**PROPOSED AND FINAL MCLs**

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PROPOSED AND FINAL MCLs (All concentrations in mg/L, except where noted)

Rev. 8/24/92

INORGANICS

Parameter	Primary MCLs				Secondary MCLs			
	FINAL	REFERENCE	OLD	PROPOSED	REFERENCE	FINAL	REFERENCE	PROPOSED REFERENCE
Asbestos	7 mil fibr	56 FR 3528 (30JAN91)						
Aluminum								
Antimony	0.008	57 FR 31776 (17JUL92)		0.0050.01(?)	56 FR 30370 (25JUL90)	0.05-0.2(**)	56 FR 3528 (30JAN91)	
Arsenic	0.05	40 CFR 141.11(b)						
Barium	2	56 FR 30280 (1JUL91)	1					
Beryllium	0.004	57 FR 31776 (17JUL92)		0.004	56 FR 30370 (25JUL90)			
Cadmium	0.005	56 FR 3528 (30JAN91)	0.010					
Chloride						250	40 CFR 143.3	
Chromium	0.1	56 FR 3528 (30JAN91)	0.05					
Copper						1	40 CFR 143.3	
Cyanide	0.2	57 FR 31776 (17JUL92)		0.2	56 ER 30370 (25JUL90)			
Iron						0.3	40 CFR 143.3	
Lead	0.05	40 CFR 141.11(b)						
Manganese						0.05	40 CFR 143.3	
Mercury	0.002	56 FR 3528 (30JAN91)	0.002					
Nickel	0.1	57 FR 31776 (17JUL92)		0.1	56 FR 30370 (25JUL90)			
Nitrate (as N)	10	56 FR 3528 (30JAN91)	10					
Nitrite (as N)	1	56 FR 3528 (30JAN91)						
Total NO <sub>3</sub> +NO <sub>2</sub> (as N)	10	56 FR 3528 (30JAN91)						
Selenium	0.05	56 FR 3528 (30JAN91)	0.01					
Silver								
Sulfide	Detected	57 FR 31776 (17JUL92)	0.05	4007500(***)	56 FR 30370 (25JUL90)	0.1	56 FR 3528 (30JAN91)	
Thallium	0.002	57 FR 31776 (17JUL92)		0.01002(?)	56 FR 30370 (25JUL90)	250	40 CFR 143.3	
Zinc						5	40 CFR 143.3	
Fluoride	4	40 CFR 141.11(c)				2.0	40 CFR 143.3	

ORGANICS

Parameter	Primary MCL				Secondary MCL			
	FINAL	REFERENCE	OLD	PROPOSED	REFERENCE	FINAL	REFERENCE	PROPOSED REFERENCE
Alcohol	0.002	56 FR 3528 (30JAN91)						
Aldehyde	0.003	56 FR 30280 (1JUL91)						
Aldicarb sulfide	0.004	56 FR 30280 (1JUL91)						
Aldicarb sulfone	0.003	56 FR 30280 (1JUL91)						
Atrazine	0.003	56 FR 3528 (30JAN91)						
Benzene	0.005	40 CFR 141.81(a)						
Carbon tetrachloride	0.04	56 FR 3528 (30JAN91)						
Carbon tetrachloride	0.005	40 CFR 141.81(c)						
Chlordane	0.002	56 FR 3528 (30JAN91)						
Dieldrin	0.2	57 FR 31776 (17JUL92)		0.2	56 FR 30370 (25JUL90)			
Dibromochloropropane	0.0002	56 FR 3528 (30JAN91)						
o-Dichlorobenzene (1,2-Dichlorobenzene)	0.6	56 FR 3528 (30JAN91)						
pure-Dichlorobenzene (1,4-Dichlorobenzene)	0.075	40 CFR 141.81(a)						
Di(2-ethylhexyl)phthalate	0.4	57 FR 31776 (17JUL92)		0.6	56 FR 30370 (25JUL90)			
Di(2-ethylhexyl)phthalate	0.008	57 FR 31776 (17JUL92)		0.004	56 FR 30370 (25JUL90)			
Diquat	0.02	57 FR 31776 (17JUL92)		0.02	56 FR 30370 (25JUL90)			
Dinoseb	0.007	57 FR 31776 (17JUL92)		0.007	56 FR 30370 (25JUL90)			
Endosulf	0.1	57 FR 31776 (17JUL92)		0.1	56 FR 30370 (25JUL90)			
Endrin	0.002	57 FR 31776 (17JUL92)	0.002	0.002	56 FR 30370 (25JUL90)			



**APPENDIX F**

**SCHEDULE OF FIELD ACTIVITIES TO FILL DATA GAPS**



Sample Identification Numbers

<u>Site</u>	<u>Abbr.</u>	<u>Sample Type</u>	<u>Sample ID No.</u>	<u>Requested Analyses</u>	<u>Date Collected</u>
<u>Wastewater Spreading Area</u>	WS	Surface Soil (0 - 2 feet)	WSS-92-01	VOCs, SVOCs, inorganics, anions	6/4/92
			WSS-92-02	VOCs, SVOCs, inorganics, anions	6/6/92
			WSS-92-03	VOCs, SVOCs, inorganics, anions	6/6/92
			WSS-92-04	VOCs, SVOCs, inorganics, anions	6/6/92
			WSS-92-05	VOCs, SVOCs, inorganics, anions	6/6/92
			WSS-92-06	VOCs, SVOCs, inorganics, anions	6/6/92
<u>Pole Transformer PCB Spill</u>	PP	Surface Soil	WSB-92-01	VOCs, SVOCs, inorganics, anions	6/4/92
			WSB-92-02	VOCs, SVOCs, inorganics, anions	6/4/92
			PPS-92-01	dioxin, pesticides/PCBs	6/5/92
			PPS-92-02	dioxin, pesticides/PCBs	6/5/92
			PPS-92-03	dioxin, pesticides/PCBs	6/5/92
			PPS-92-04	dioxin, pesticides/PCBs	6/5/92
			PPT-92-01	dioxin, pesticides/PCBs	6/5/92
			PPT-92-02	dioxin, pesticides/PCBs	6/5/92
			PPT-92-03	dioxin, pesticides/PCBs	6/5/92
			PPT-92-04	dioxin, pesticides/PCBs	6/5/92
<u>Old Burn Area</u> Test pit 1	OB	Surface Soil	PPT-92-05	dioxin, pesticides/PCBs	6/5/92
			OBS-92-101	SVOCs, inorganics, anions, explosives	6/17/92
			OBP-92-101	VOCs, SVOCs, inorganics, anions, explosives	6/17/92
			OBP-92-102	VOCs, SVOCs, inorganics, anions, explosives	6/17/92
Test Pit 2			OBP-92-103	VOCs, SVOCs, inorganics, anions, explosives	6/17/92
			OBP-92-104	VOCs, SVOCs, inorganics, anions, explosives	6/17/92
			OBS-92-201	SVOCs, inorganics, anions, explosives	6/18/92
			OBP-92-201	VOCs, SVOCs, inorganics, anions, explosives	6/18/92
		Subsurface Soil	OBP-92-202	VOCs, SVOCs, inorganics, anions, explosives	6/18/92

(continued)

<u>Site</u>	<u>Abbr.</u>	<u>Sample Type</u>	<u>Sample ID No.</u>	<u>Requested Analyses</u>	<u>Date Collected</u>
Test Pit 3				explosives	
			OBP-92-203	VOCs, SVOCs, inorganics, anions, explosives	6/18/92
			OBP-92-204	VOCs, SVOCs, inorganics, anions, explosives	6/18/92
			OBS-92-301	SVOCs, inorganics, anions,	6/19/92
		Surface Soil	OBP-92-301	VOCs, SVOCs, inorganics, anions, explosives	6/19/92
		Subsurface Soil	OBP-92-302	VOCs, SVOCs, inorganics, anions, explosives	6/19/92
			OBP-92-303	VOCs, SVOCs, inorganics, anions, explosives	6/19/92
			OBP-92-304	VOCs, SVOCs, inorganics, anions, explosives	6/19/92
Test Pit 4		Surface Soil	OBS-92-401	SVOCs, inorganics, explosives	6/20/92
			OBP-92-402	SVOCs, inorganics, explosives, reactivity	6/20/92
Gully Locations		Surface Soil	OBP-92-403	SVOCs, inorganics, explosives	6/20/92
			OBP-92-404	SVOCs, inorganics, explosives	6/20/92
			OBS-92-G01	Explosives, SVOCs, inorganics	6/7/92
			OBS-92-G02	Explosives, SVOCs, inorganics	6/7/92
			OBS-92-G03	Explosives, SVOCs, inorganics	6/7/92
			OBS-92-G04	Explosives, SVOCs, inorganics	6/7/92
			OBS-92-G05	Explosives, SVOCs, inorganics	6/7/92
<u>Old Burn Staging Area</u>	OS				
Depression Perimeter		Surface Soil	OSS-92-05	SVOCs, inorganics, explosives, anions	6/23/92
			OSS-92-06	SVOCs, inorganics, explosives, anions	6/23/92
Burn areas north of pit		Surface Soil	OSS-92-07	SVOCs, inorganics, explosives, anions	6/23/92
			OSS-92-08	SVOCs, inorganics, explosives, anions	6/23/92
			OSS-92-09	SVOCs, inorganics, explosives, anions	6/23/92
			OSS-92-10	SVOCs, inorganics, explosives, anions	6/23/92
			OSS-92-11	SVOCs, inorganics, explosives, anions	6/23/92



(continued)

<u>Site</u>	<u>Abbr.</u>	<u>Sample Type</u>	<u>Sample ID No.</u>	<u>Requested Analyses</u>	<u>Date Collected</u>
Chemical Range Trench 1	CR	Surface Soil Subsurface Soil	OSS-92-12	SVOCs, inorganics, explosives, anions	6/23/92
			OSS-92-13	SVOCs, inorganics, explosives, anions	6/23/92
Trench 2		Surface Soil Subsurface Soil	CRS-92-101	SVOCs, inorganics, anions, explosives	6/21/92
			CRT-92-101	SVOCs, inorganics, anions, explosives	6/21/92
Trench 3		Surface Soil Subsurface Soil	CRT-92-102	SVOCs, inorganics, anions, explosives	6/21/92
			CRT-92-103	SVOCs, inorganics, anions, explosives	6/21/92
			CRT-92-104	SVOCs, inorganics, anions, explosives	6/21/92
			CRS-92-201	SVOCs, inorganics, anions, explosives	6/22/92
			CRT-92-201	SVOCs, inorganics, anions, explosives	6/22/92
			CRT-92-202	SVOCs, inorganics, anions, explosives	6/22/92
			CRT-92-203	SVOCs, inorganics, anions, explosives	6/22/92
			CRT-92-204	SVOCs, inorganics, anions, explosives	6/22/92
		Surface Soil Subsurface Soil	CRS-92-301	SVOCs, inorganics, anions, explosives	6/23/92
			CRT-92-301	SVOCs, inorganics, anions, explosives	6/23/92
			CRT-92-302	SVOCs, inorganics, anions, explosives	6/23/92
			CRT-92-303	SVOCs, inorganics, anions, explosives	6/23/92
<u>Building 1303 Washout Pond</u>	BW	Surface Soil reactivity	CRT-92-304	SVOCs, inorganics, anions, explosives	6/23/92
			BWS-92-01	Explosives, inorganics, anions,	6/4/92
			BWS-92-02	Explosives, inorganics, anions,	6/4/92
				reactivity	
			BWS-92-03	Explosives, inorganics, anions	6/4/92
			BWS-92-04	Explosives, inorganics, anions	6/4/92
			BWS-92-05	Explosives, inorganics, anions	6/4/92
			BWS-92-06	Explosives, inorganics, anions	6/4/92
			BWS-92-07	Explosives, inorganics, anions	6/4/92
			BWS-92-08	Explosives, inorganics, anions	6/4/92
			BWS-92-09	Explosives, inorganics, anions	6/4/92
			BWS-92-10	Explosives, inorganics, anions	6/4/92
<u>Bomb and Shell Recond. Building</u>	BR	Surface Soil	BRS-92-01	VOCs, SVOCs, inorganics, explosives	7/10/92
			BRS-92-02	VOCs, SVOCs, inorganics, explosives	7/10/92

(continued)

<u>Site</u>	<u>Abbr.</u>	<u>Sample Type</u>	<u>Sample ID No.</u>	<u>Requested Analyses</u>	<u>Date Collected</u>
<u>AED Test Range</u> Test Pit 1	AR	Surface Soil Subsurface Soil	BRS-92-03	VOCs, SVOCs, inorganics, explosives	7/10/92
			BRS-92-04	VOCs, SVOCs, inorganics, explosives	7/10/92
			BRS-92-05	VOCs, SVOCs, inorganics, explosives	7/10/92
			BRS-92-06	VOCs, SVOCs, inorganics, explosives	7/10/92
			BRS-92-07	VOCs, SVOCs, inorganics, explosives	7/10/92
			BRS-92-08	VOCs, SVOCs, inorganics, explosives	7/10/92
			BRS-92-09	VOCs, SVOCs, inorganics, explosives	7/10/92
			BRW-92-01	VOCs, SVOCs, inorganics, explosives, pesticides/PCBs, anions	7/15/92
			BRD-92-01	VOCs, SVOCs, inorganics, explosives, reactivity	7/10/92
		Test Pit 2		Surface Soil Subsurface Soil	ARS-92-101
ARP-92-101	SVOCs, inorganics, anions, explosives				7/7/92
Test Pit 3		Surface Soil Subsurface Soil	ARS-92-201	SVOCs, inorganics, anions, explosives	7/8/92
			ARP-92-201	SVOCs, inorganics, anions, explosives	7/8/92
Test Pit 4		Surface Soil Subsurface Soil	ARS-92-301	SVOCs, inorganics, anions, explosives	7/8/92
			ARP-92-301	SVOCs, inorganics, anions, explosives	7/8/92
Building Perimeter		Surface Soil Subsurface Soil	ARS-92-401	SVOCs, inorganics, anions, explosives	7/9/92
			ARP-92-401	SVOCs, inorganics, anions, explosives	7/9/92
Revetment 2 Revetment 3 Revetment 6		Surface Soil Surface Soil Surface Soil	ARS-92-B01	SVOCs, inorganics, anions, explosives	7/9/92
			ARS-92-B02	SVOCs, inorganics, anions, explosives	7/9/92
			ARS-92-B03	SVOCs, inorganics, anions, explosives	7/9/92
			ARS-92-B04	SVOCs, inorganics, anions, explosives	7/9/92
		Surface Soil Surface Soil Surface Soil	ARS-92-R21	SVOCs, inorganics, anions, explosives	7/9/92
			ARS-92-R31	SVOCs, inorganics, anions, explosives	7/9/92
			ARS-92-R61	SVOCs, inorganics, anions, explosives	7/9/92

(continued)

<u>Site</u>	<u>Abbr.</u>	<u>Sample Type</u>	<u>Sample ID No.</u>	<u>Requested Analyses</u>	<u>Date Collected</u>
Small Arms Firing Range	SAS	Surface Soil	SAS-92-01	TCLP metals	6/5/92
			SAS-92-02	TCLP metals	6/5/92
			SAS-92-03	TCLP metals	6/5/92
			SAS-92-04	TCLP metals	6/5/92
<u>Box Elder Wash Drum Site</u>	BE				
Opened Drum Samples		Drum - Solid	BER-92-01	VOCs, SVOCs, TCLP metals, anions, explosives	6/9/92
			BER-92-02	VOCs, SVOCs, TCLP metals, anions, explosives	7/13/92
			BER-92-03	VOCs, SVOCs, TCLP metals, anions, explosives	7/13/92
			BER-92-04	VOCs, SVOCs, TCLP metals, anions, explosives	7/14/92
Unopened Drum Samples		Drum - Solid	BER-92-05	VOCs, SVOCs, TCLP metals, anions, explosives	6/10/92
			BER-92-06	VOCs, SVOCs, TCLP metals, anions, explosives	7/14/92
			BER-92-07	VOCs, SVOCs, TCLP metals, anions, explosives	7/14/92
			BER-92-08	VOCs, SVOCs, TCLP metals, anions, explosives	7/14/92
			BES-92-01	VOCs, SVOCs, TCLP metals, anions, explosives	6/9/92
			BES-92-02	VOCs, SVOCs, TCLP metals, anions, explosives	6/9/92
			BES-92-03	VOCs, SVOCs, TCLP metals, anions, explosives	6/9/92
			BES-92-04	VOCs, SVOCs, TCLP metals, anions, explosives	6/9/92
Surrounding Soils		Surface Soil			

(continued)

<u>Site</u>	<u>Abbr.</u>	<u>Sample Type</u>	<u>Sample ID No.</u>	<u>Requested Analyses</u>	<u>Date Collected</u>
Downstream Soils			BES-92-05	VOCs, SVOCs, TCLP metals, anions, explosives	6/10/92
			BES-92-06	VOCs, SVOCs, TCLP metals, anions, explosives	6/9/92
			BES-92-07	VOCs, SVOCs, TCLP metals, anions, explosives	6/9/92
			BES-92-08	VOCs, SVOCs, TCLP metals, anions, explosives	6/9/92
			BES-92-09	VOCs, SVOCs, TCLP metals, anions, explosives	7/14/92
Subsurface Soil			BEB-92-01	VOCs, SVOCs, TCLP metals, anions, explosives	6/10/92
			BEB-92-02	VOCs, SVOCs, TCLP metals, anions, explosives	6/10/92
			BEB-92-03	VOCs, SVOCs, TCLP metals, anions, explosives	6/10/92
			BEB-92-04	VOCs, SVOCs, TCLP metals, anions, explosives	6/10/92

**APPENDIX G**

**POTABLE WELL WATER ANALYSIS**

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# FORD ANALYTICAL LABORATORIES

CHEMICAL AND BACTERIOLOGICAL ANALYSIS

## CERTIFICATE OF ANALYSIS

DATE: 07/30/90

TOOELE ARMY DEPOT  
ENV. MGT. OFF (R. CLARK)  
BLDG. 113  
TOOELE, UT 84074

90-007974

SAMPLE: WATER SAMPLE FROM NORTH WELL #1 RECEIVED 7-16-90 FOR  
ANALYSIS STARTING AT 5 P.M. UNDER PO #W67QJA-0136-0140.

### RESULTS

=====

Nitrate, NO <sub>3</sub> -N mg/l SM418C	.15	max = 10 ppm
Sulfate, SO <sub>4</sub> mg/l EPA 375.2	22.6	max = 250. ppm

  
-----  
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# FORD ANALYTICAL LABORATORIES

CHEMICAL AND BACTERIOLOGICAL ANALYSIS

## CERTIFICATE OF ANALYSIS

DATE: 08/02/90

TOOELE ARMY DEPOT  
ENV. MGT. OFF (R. CLARK)  
BLDG. 113  
TOOELE, UT 84074

90-007963

SAMPLE: WATER SAMPLE FROM NORTH WELL #1 COLLECTED AND RECEIVED  
7-16-90 FOR REGULATED VOC ANALYSIS UNDER REQ. #W67QJA-  
0156-0140.

### RESULTS

=====

1,2-Dichloroethane ppm 502.2	<.001
111Trichloroethane ppm 502.2	<.001
11Dichloroethylene ppm 502.2	<.001
Benzene ppm 502.1	<.001
C. Tetrachloride ppm 502.2	<.001
Trichloroethylene ppm 502.2	<.001
Vinyl Chloride ppm 502.2	<.001
p-Dichlorobenzene ppm 502.2	<.001

  
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**FORD ANALYTICAL LABORATORIES**

CHEMICAL AND BACTERIOLOGICAL ANALYSIS

## CERTIFICATE OF ANALYSIS

DATE: 08/02/90

TOOELE ARMY DEPOT  
ENV. MGT. OFF (R. CLARK)  
BLDG. 113  
TOOELE, UT 84074

90-007964

SAMPLE: WATER SAMPLE FROM NORTH WELL #1 COLLECTED AND RECEIVED  
7-16-90 FOR UNREGULATED VOC ANALYSIS STARTING AT 5 P.M.  
UNDER REQ. #W67QJA-0156-0140.

## RESULTS

=====

1,1 Dichloroethane ppm	<.001
1,1,1,2-Tetrachloroethane ppm	<.001
1,1,2,2-Tetrachloroethane ppm	<.001
1,1,2-Trichloroethane ppm	<.001
1,1-Dichloropropene ppm	<.001
1,2,3-Trichloropropane ppm	<.001
1,2,3-Trichlorobenzene ppm	<.001
1,2,4-Trichlorobenzene ppm	<.001
1,2,4-Trimethylbenzene ppm	<.001
1,2-Dibromo-3-chloropropane p	<.001
1,2-Dibromoethane (EDB) ppm	<.001
1,2-Dichloropropane ppm	<.001
1,3,5-Trimethylbenzene ppm	<.001

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## CERTIFICATE OF ANALYSIS

PAGE: 2

90-007964

## RESULTS

=====

1,3-Dichloropropane PPM	<.001
2,2-Dichloropropene PPM	<.001
Bromobenzene PPM	<.001
Bromochloromethane PPM	<.001
Bromodichloromethane PPM	<.001
Bromoform PPM	<.001
Bromomethane PPM	<.001
Chlorobenzene PPM	<.001
Chlorodibromomethane PPM	<.001
Chloroethane PPM	<.001
Chloroform PPM	<.001
Dibromochloromethane PPM	<.001
Dibromomethane PPM	<.001
Dichlorodifluoromethane PPM	<.001
Dichloromethane PPM	<.001
Ethylbenzene PPM	<.001
Fluorotrichloromethane PPM	<.001

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## RESULTS

Hexachlorobutadiene PPM	<.001
Naphthalene PPM	<.001
Styrene PPM	<.001
Tetrachloroethene PPM	<.001
Toluene PPM	<.001
cis-1,2-Dichloroethylene PPM	<.001
cis-1,3-Dichloropropene PPM	<.001
iso-Propylbenzene PPM	<.001
m-Dichlorobenzene PPM	<.001
m-Xylene PPM	<.001
n-Butylbenzene PPM	<.001
n-Propylbenzene PPM	<.001
o-Chlorotoluene PPM	<.001
o-Dichlorobenzene PPM	<.001
o-Xylene PPM	<.001
p-Chlorotoluene PPM	<.001
p-Isopropyltoluene PPM	<.001

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## CERTIFICATE OF ANALYSIS

PAGE: 4

90-007964

## RESULTS

=====

p-Xylene PPM	<.001
sec-Butylbenzene PPM	<.001
tert-Butylbenzene PPM	<.001
trans-1,2-Dichloroethylene PP	<.001
trans-1,3-Dichloropropene PPM	<.001

  
-----  
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# FORD ANALYTICAL LABORATORIES

CHEMICAL AND BACTERIOLOGICAL ANALYSIS

## CERTIFICATE OF ANALYSIS

DATE: 07/27/90

TOOELE ARMY DEPOT  
ENV.MGT.OFF(R.CLARK)  
BLDG. 113  
TOOELE, UT 84074

90-007965

SAMPLE: WATER SAMPLE FROM NORTH WELL #2 COLLECTED AND RECEIVED  
7-16-90 FOR REGULATED VOC ANALYSIS UNDER REQ. #W67QJA-0156-  
0140.

### RESULTS

=====

1,2-Dichloroethane PPM 502.2	<.001
111Trichloroethane PPM 502.2	<.001
11Dichloroethylene PPM 502.2	<.001
Benzene PPM 502.1	<.001
C. Tetrachloride PPM 502.2	<.001
Trichloroethylene PPM 502.2	<.001
Vinyl Chloride PPM 502.2	<.001
p-Dichlorobenzene PPM 502.2	<.001

  
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**FORD ANALYTICAL LABORATORIES**

CHEMICAL AND BACTERIOLOGICAL ANALYSIS

## CERTIFICATE OF ANALYSIS

DATE: 08/15/90

TOOELE ARMY DEPOT  
ENV. MGT. OFF (R. CLARK)  
BLDG. 113  
TOOELE, UT 84074

90-007966

SAMPLE: WATER SAMPLE FROM NORTH WELL #2 COLLECTED AND RECEIVED  
7-16-90 FOR UNREGULATED VOC ANALYSIS UNDER REQ. #W67QJA0156-  
0140.

## RESULTS

=====

1,1 Dichloroethane PPM	<.001
1,1,1,2-Tetrachloroethane PPM	<.001
1,1,2,2-Tetrachloroethane PPM	<.001
1,1,2-Trichloroethane PPM	<.001
1,1-Dichloropropene PPM	<.001
1,2,3-Trichloropropane PPM	<.001
1,2,3-Trichlorobenzene PPM	<.001
1,2,4-Trichlorobenzene PPM	<.001
1,2,4-Trimethylbenzene PPM	<.001
1,2-Dibromo-3-chloropropane P	<.001
1,2-Dibromoethane (EDB) PPM	<.001
1,2-Dichloropropane PPM	<.001
1,3,5-Trimethylbenzene PPM	<.001

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**FORD ANALYTICAL LABORATORIES**

CHEMICAL AND BACTERIOLOGICAL ANALYSIS

CERTIFICATE OF ANALYSIS

PAGE: 2

90-007966

**RESULTS**

-----

1,3-Dichloropropane ppm	<.001
2,2-Dichloropropene ppm	<.001
Bromobenzene ppm	<.001
Bromochloromethane ppm	<.001
Bromodichloromethane ppm	<.001
Bromoform ppm	<.001
Bromomethane ppm	<.001
Chlorobenzene ppm	<.001
Chlorodibromomethane ppm	<.001
Chloroethane ppm	<.001
Chloroform ppm	<.001
Dibromochloromethane ppm	<.001
Dibromomethane ppm	<.001
Dichlorodifluoromethane ppm	<.001
Dichloromethane ppm	<.001
Ethylbenzene ppm	<.001
Fluorotrichloromethane ppm	<.001

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## CERTIFICATE OF ANALYSIS

PAGE: 3

90-007966

## RESULTS

=====

Hexachlorobutadiene PPM	<.001
Naphthalene PPM	<.001
Styrene PPM	<.001
Tetrachloroethene PPM	<.001
Toluene PPM	<.001
cis-1,2-Dichloroethylene PPM	<.001
cis-1,3-Dichloropropene PPM	<.001
iso-Propylbenzene PPM	<.001
m-Dichlorobenzene PPM	<.001
m-Xylene PPM	<.001
n-Butylbenzene PPM	<.001
n-Propylbenzene PPM	<.001
o-Chlorotoluene PPM	<.001
o-Dichlorobenzene PPM	<.001
o-Xylene PPM	<.001
p-Chlorotoluene PPM	<.001
p-Isopropyltoluene PPM	<.001

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## CERTIFICATE OF ANALYSIS

PAGE: 4

90-007966

## RESULTS

=====

p-Xylene ppm	<.001
sec-Butylbenzene ppm	<.001
tent-Butylbenzene ppm	<.001
trans-1,2-Dichloroethylene pp	<.001
trans-1,3-Dichloropropene ppm	<.001

  
-----  
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# FORD ANALYTICAL LABORATORIES

CHEMICAL AND BACTERIOLOGICAL ANALYSIS

## CERTIFICATE OF ANALYSIS

DATE: 07/27/90

TOOELE ARMY DEPOT  
ENV. MGT. OFF (R. CLARK)  
BLDG. 113  
TOOELE, UT 84074

90-007967

SAMPLE: WATER SAMPLE FROM NORTH WELL #3 COLLECTED AND RECEIVED  
7-16-90 FOR REGULATED VOC ANALYSIS UNDER REQ. #W67QJA-  
0156-0140.

### RESULTS

=====

1,2-Dichloroethane ppm 502.2	<.001
111Trichloroethane ppm 502.2	<.001
11Dichloroethylene ppm 502.2	<.001
Benzene ppm 502.1	<.001
C. Tetrachloride ppm 502.2	<.001
Trichloroethylene ppm 502.2	<.001
Vinyl Chloride ppm 502.2	<.001
p-Dichlorobenzene ppm 502.2	<.001

  
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CHEMICAL AND BACTERIOLOGICAL ANALYSIS

## CERTIFICATE OF ANALYSIS

DATE: 07/27/90

TOOELE ARMY DEPOT  
ENV. MGT. OFF (R. CLARK)  
BLDG. 113  
TOOELE, UT 84074

90-007968

SAMPLE: WATER SAMPLE FROM NORTH WELL #3 COLLECTED AND RECEIVED  
7-16-90 FOR UNREGULATED VOC ANALYSIS UNDER REQ. #W67QJA-  
0156-0140.

## RESULTS

=====

1,1 Dichloroethane PPM	<.001
1,1,1,2-Tetrachloroethane PPM	<.001
1,1,2,2-Tetrachloroethane PPM	<.001
1,1,2-Trichloroethane PPM	<.001
1,1-Dichloropropene PPM	<.001
1,2,3-Trichloropropane PPM	<.001
1,2,3-Trichlorobenzene PPM	<.001
1,2,4-Trichlorobenzene PPM	<.001
1,2,4-Trimethylbenzene PPM	<.001
1,2-Dibromo-3-chloropropane P	<.001
1,2-Dibromoethane (EDB) PPM	<.001
1,2-Dichloropropane PPM	<.001
1,3,5-Trimethylbenzene PPM	<.001

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**FORD ANALYTICAL LABORATORIES**

CHEMICAL AND BACTERIOLOGICAL ANALYSIS

CERTIFICATE OF ANALYSIS

PAGE: 2

90-007968

## RESULTS

1,3-Dichloropropane PPM	<.001
2,2-Dichloropropene PPM	<.001
Bromobenzene PPM	<.001
Bromochloromethane PPM	<.001
Bromodichloromethane PPM	<.001
Bromoform PPM	<.001
Bromomethane PPM	<.001
Chlorobenzene PPM	<.001
Chlorodibromomethane PPM	<.001
Chloroethane PPM	<.001
Chloroform PPM	<.001
Dibromochloromethane PPM	<.001
Dibromomethane PPM	<.001
Dichlorodifluoromethane PPM	<.001
Dichloromethane PPM	<.001
Ethylbenzene PPM	<.001
Fluorotrichloromethane PPM	<.001

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**FORD ANALYTICAL LABORATORIES**

CHEMICAL AND BACTERIOLOGICAL ANALYSIS

CERTIFICATE OF ANALYSIS

PAGE: 3

90-007968

## RESULTS

=====	=====
Hexachlorobutadiene PPM	<.001
Naphthalene PPM	<.001
Styrene PPM	<.001
Tetrachloroethane PPM	<.001
Toluene PPM	<.001
cis-1,2-Dichloroethylene PPM	<.001
cis-1,3-Dichloropropene PPM	<.001
iso-Propylbenzene PPM	<.001
m-Dichlorobenzene PPM	<.001
m-Xylene PPM	<.001
n-Butylbenzene PPM	<.001
n-Propylbenzene PPM	<.001
o-Chlorotoluene PPM	<.001
o-Dichlorobenzene PPM	<.001
o-Xylene PPM	<.001
p-Chlorotoluene PPM	<.001
p-Isopropyltoluene PPM	<.001

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# FORD ANALYTICAL LABORATORIES

CHEMICAL AND BACTERIOLOGICAL ANALYSIS

## CERTIFICATE OF ANALYSIS

PAGE: 4

90-007963

### RESULTS

=====

p-Xylene ppm	<.001
sec-Butylbenzene ppm	<.001
tert-Butylbenzene ppm	<.001
trans-1,2-Dichloroethylene PP	<.001
trans-1,3-Dichloropropene ppm	<.001

  
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**APPENDIX H**

**CONCEPTUAL SITE MODELS**

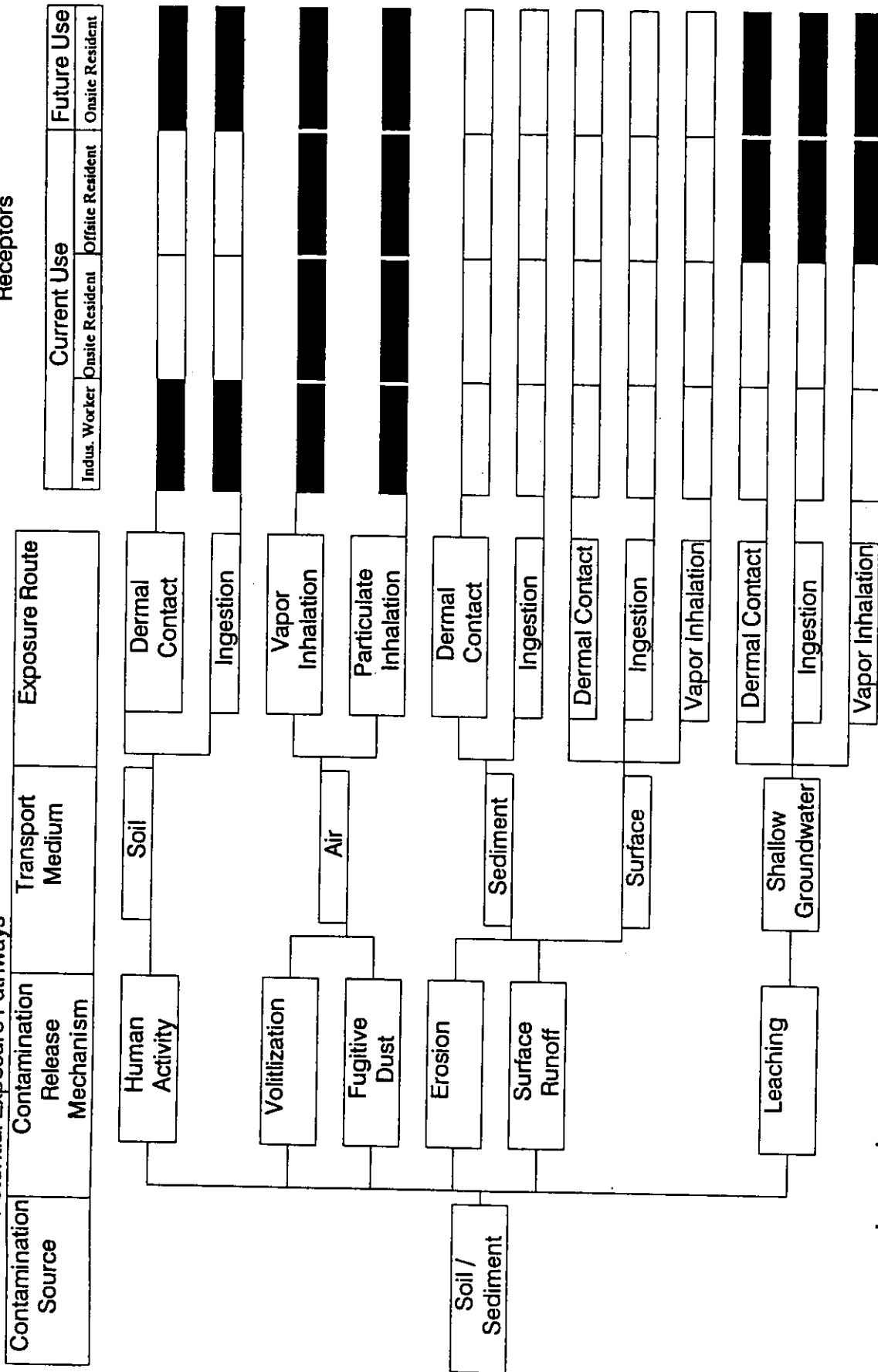




Conceptual Site Model – SITES/SWMUs 12,14,15,17,29,31,32 (INDUS. AREA)

Potential Exposure Pathways

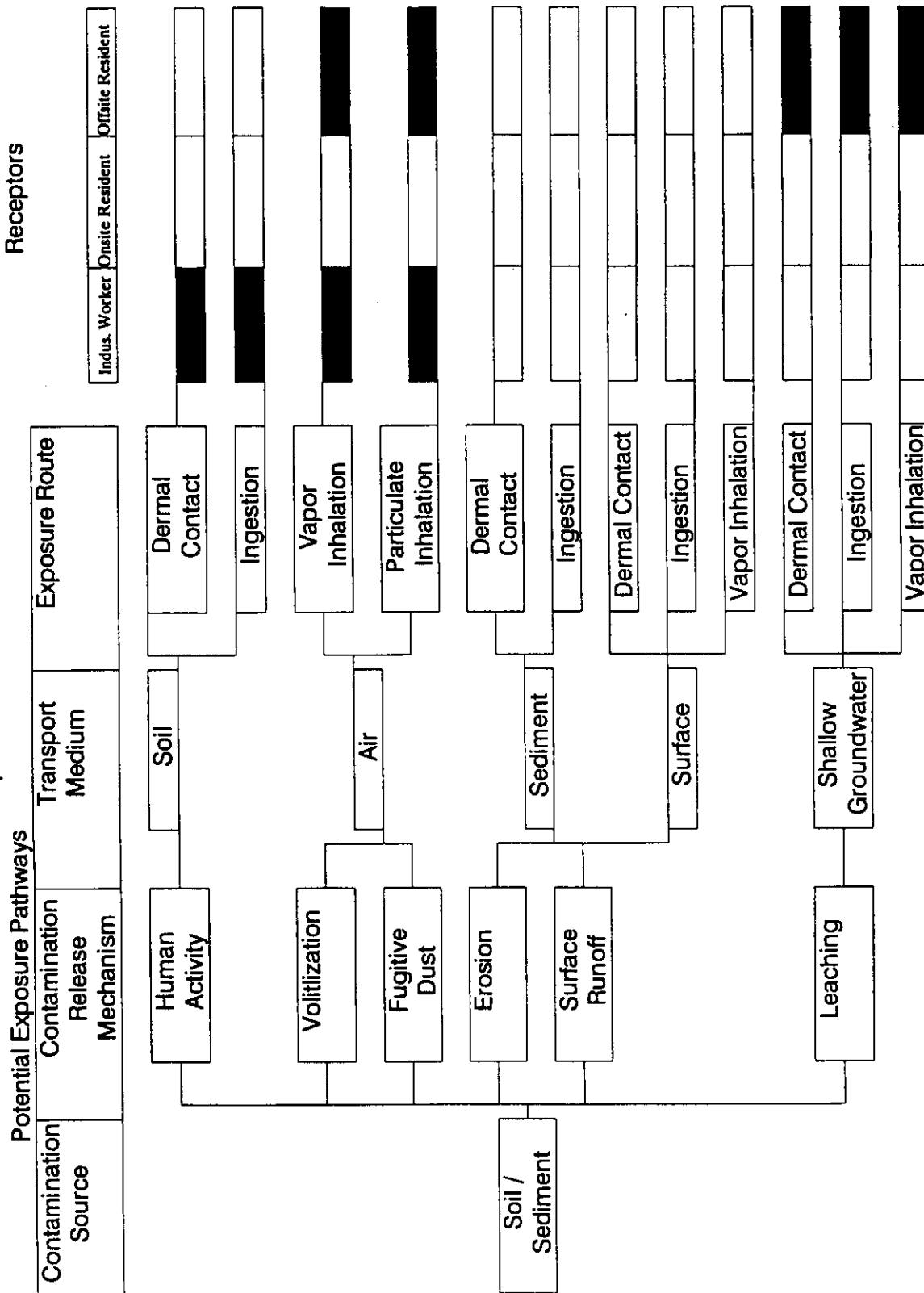
Receptors



Legend

- complete pathway
- incomplete pathway

# Conceptual Site Model – SITE WIDE

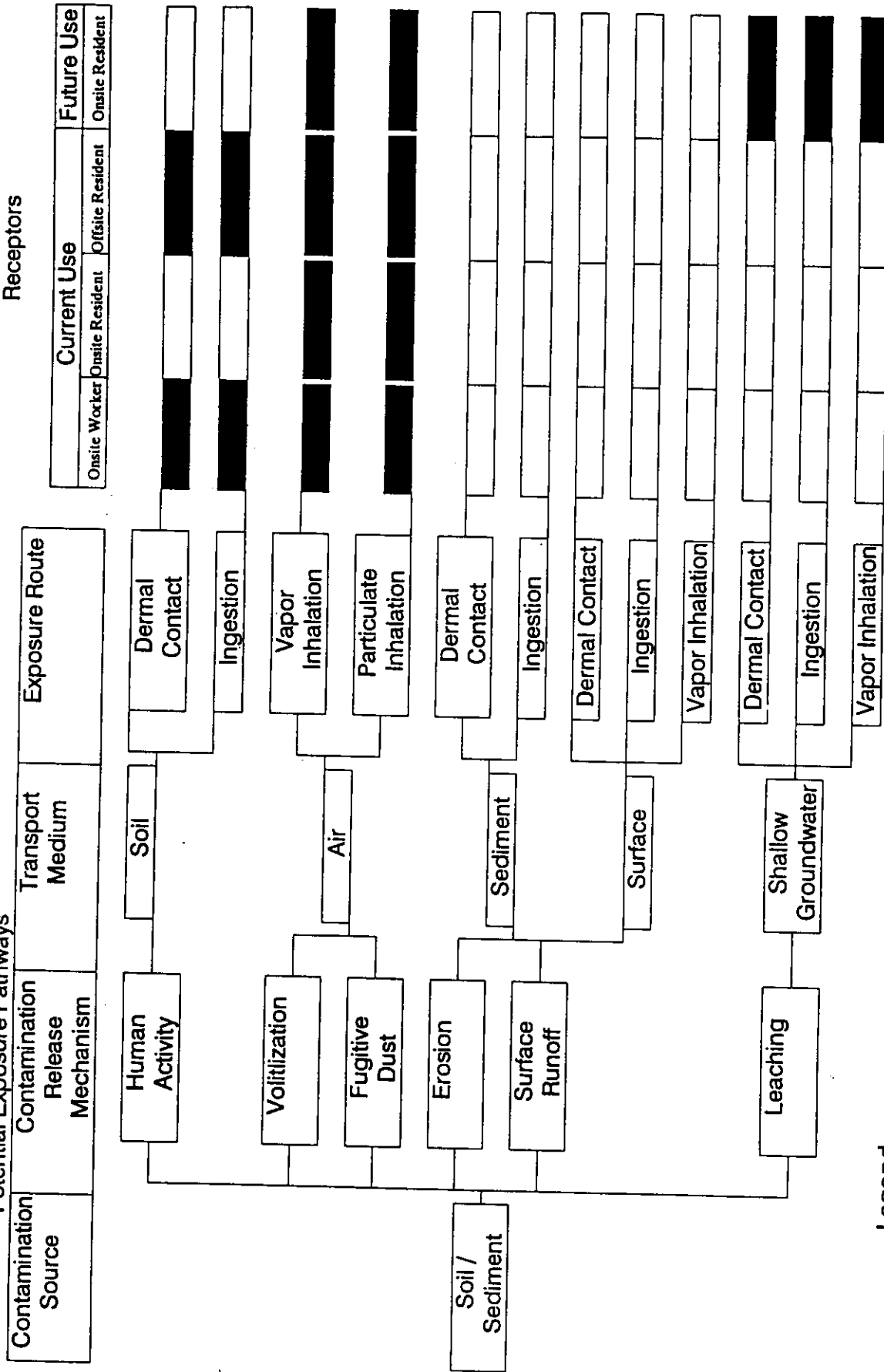


**Legend**

- complete pathway
- incomplete pathway

Conceptual Site Model – SWMU 1 (OB/OD)

Potential Exposure Pathways

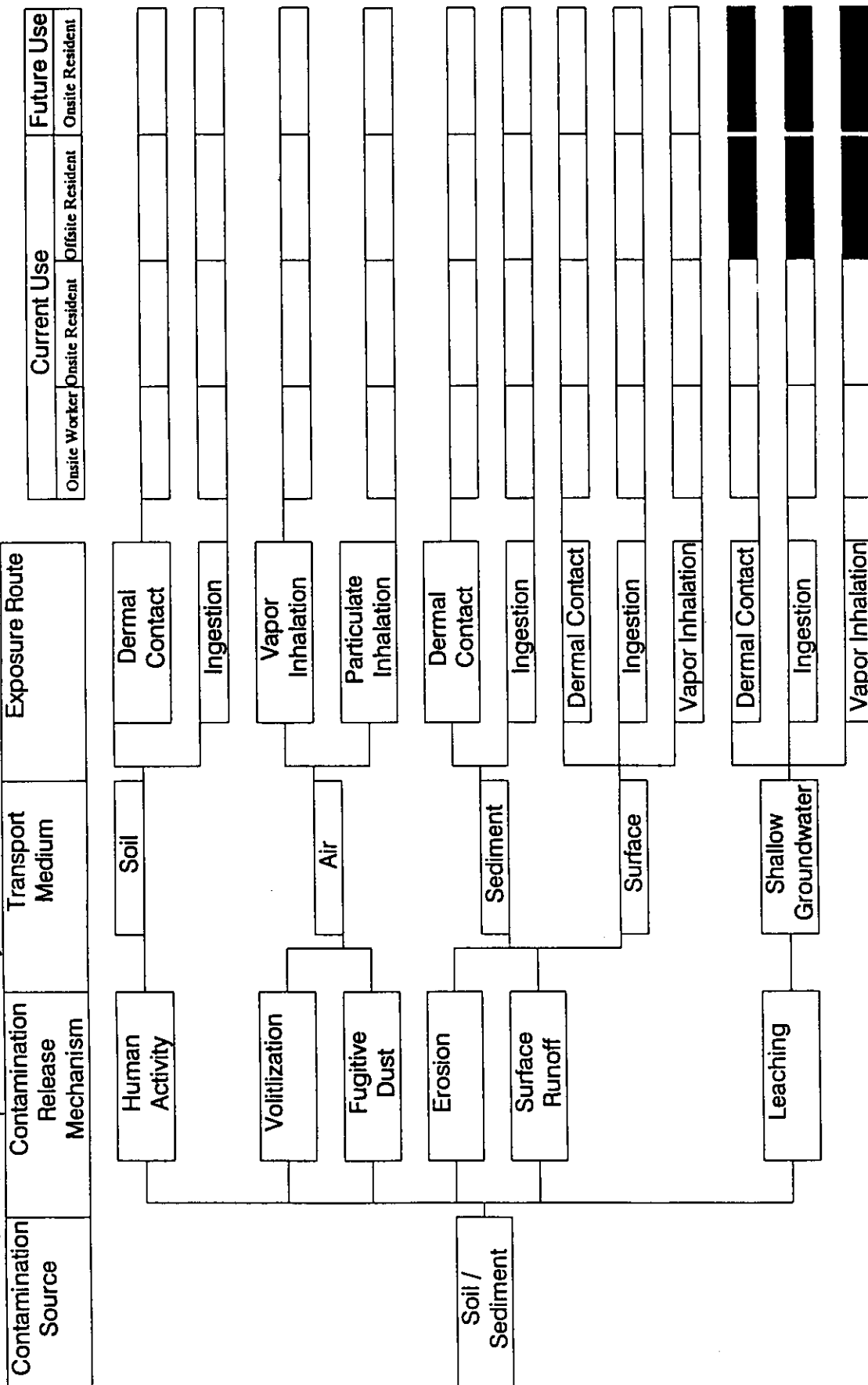




**Legend**  
 – complete pathway  
 – incomplete pathway

Conceptual Site Model – SWMU 2 (IWL)

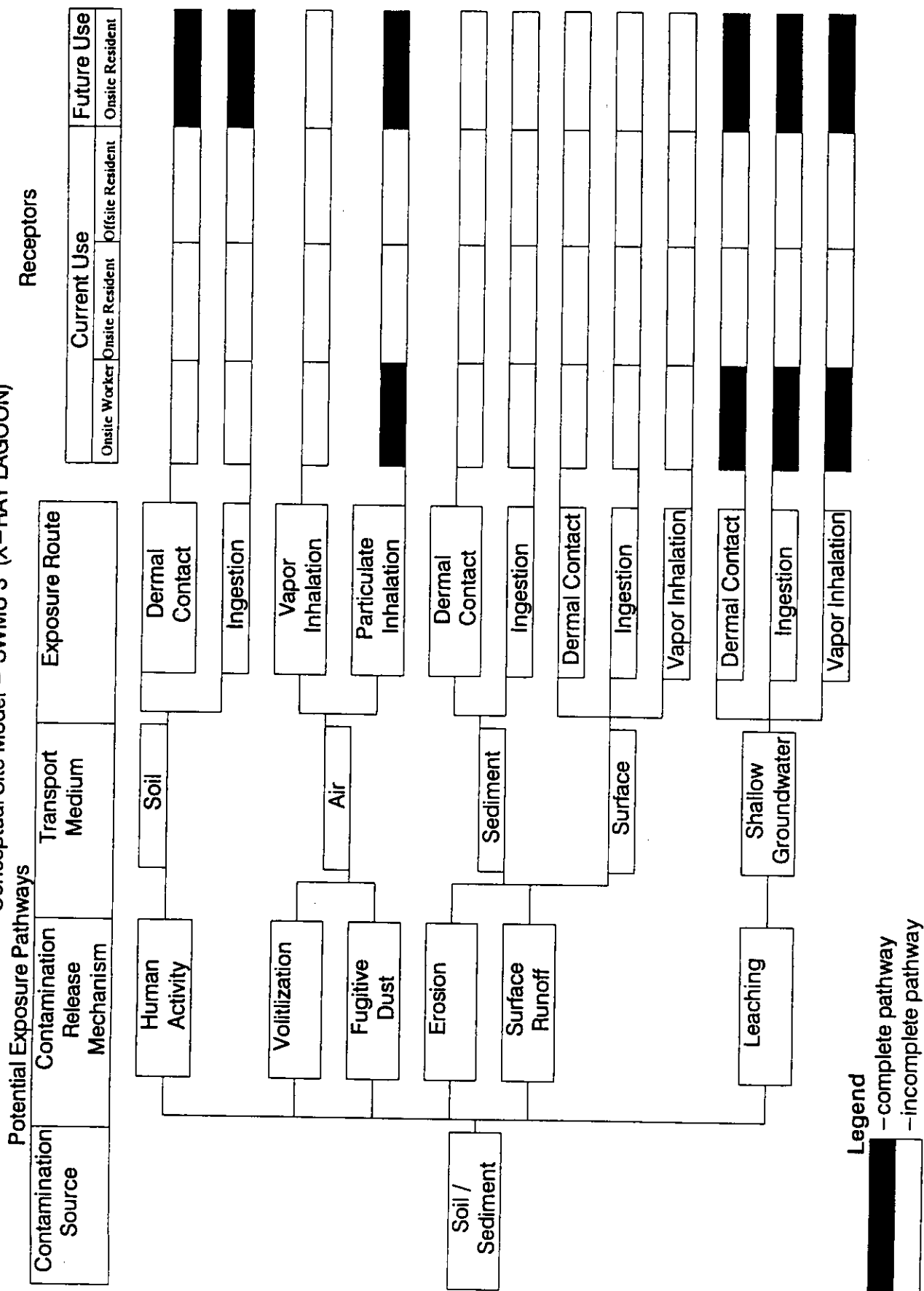
Receptors

Potential Exposure Pathways



**Legend**  
 –complete pathway  
 –incomplete pathway

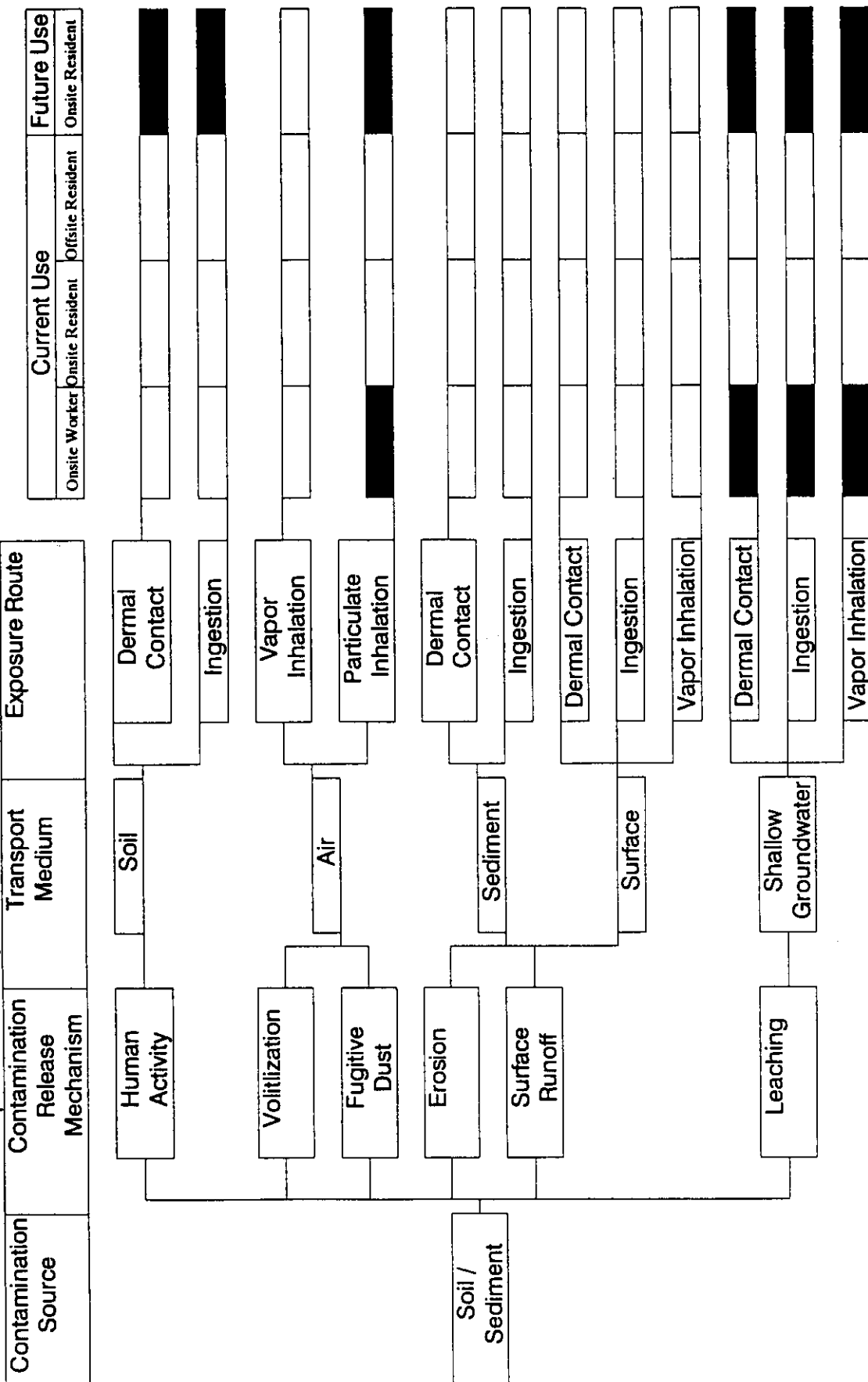
### Potential Exposure Pathways



Conceptual Site Model – Site 7 (CHEMICAL RANGE)

Potential Exposure Pathways

Receptors



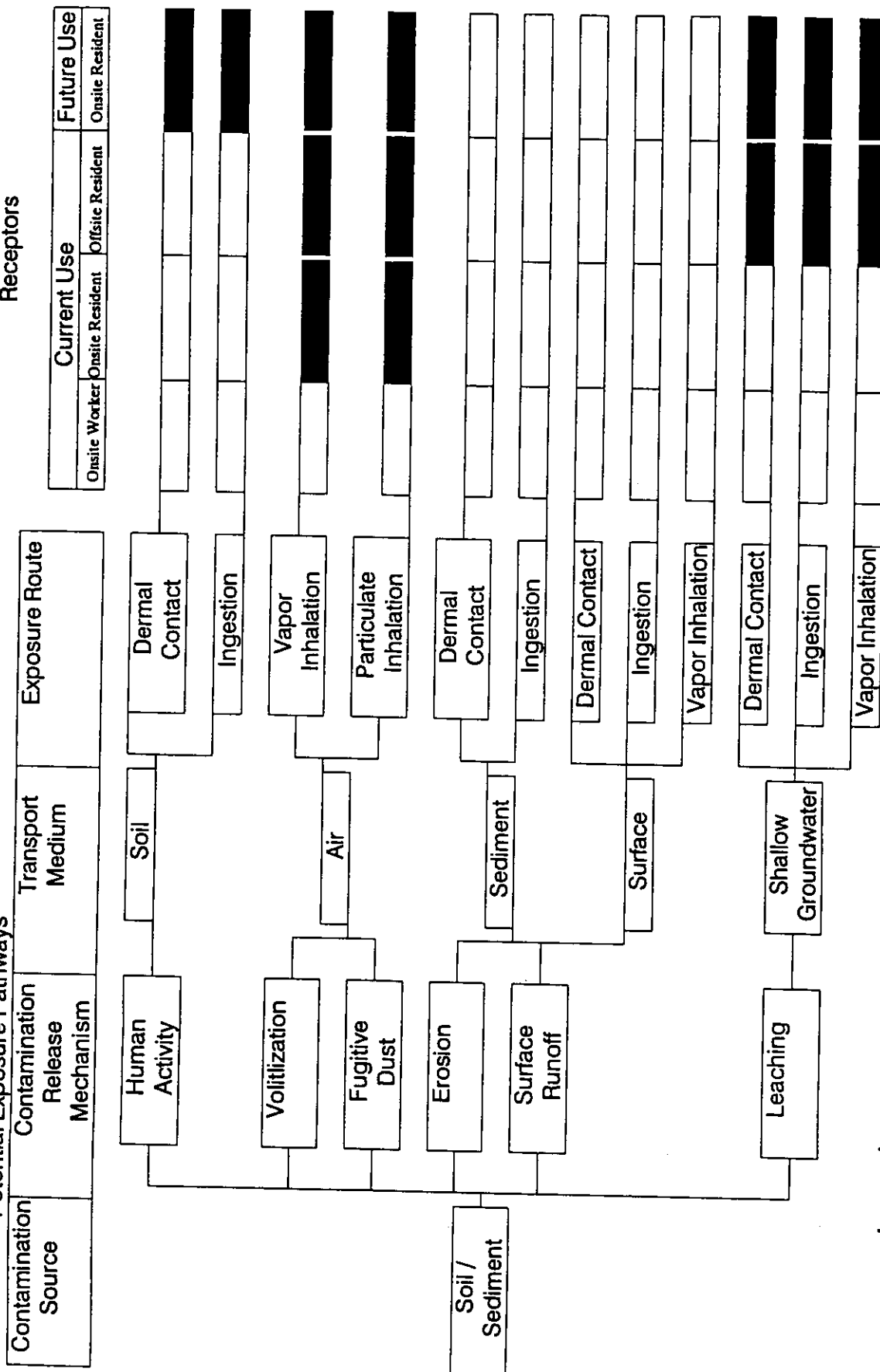
Legend

- complete pathway
- incomplete pathway

Conceptual Site Model – SWMUs 10/11 (TNT WASHOUT FACILITY)

Potential Exposure Pathways

Receptors



Legend  
 — complete pathway  
 — incomplete pathway





**APPENDIX I**

**CERTIFIED REPORTING LIMITS**



Tooele North  
Certified Reporting Limits

Analyte Name	Soils CRL (UG/G)	Water CRL (UG/L)
<hr/> <hr/> <b>ANION</b>		
BROMIDE	0.000000	0.000000
CHLORIDE	4.415000	25.000000
FLUORIDE	19.800000	136.500000
NITRATE	9.600000	35.500000
NITRITE	1.680000	12.150000
PHOSPHATE	1.580000	14.150000
SULFATE	0.000000	16.500000
	7.200000	68.500000
<hr/> <hr/> <b>CYANIDE</b>		
CYANIDE	2.500000	2.500000
<hr/> <hr/> <b>EXPLOSIVE</b>		
1,3,5-TRINITROBENZENE	0.176000	0.194000
1,3-DINITROBENZENE	0.152000	0.135000
2,4,6-TRINITROTOLUENE	0.465500	0.383500
2,4-DINITROTOLUENE	0.372000	0.580000
2,6-DINITROTOLUENE	0.415000	0.555000
2-NITROTOLUENE	0.000000	0.000000
CYCLOTETRAMETHYLENETETRANITRAMINE	0.377500	0.424500
CYCLOTRIMETHYLENETRINITRAMINE/CYCLONITE	0.222500	0.308500
2-METHYL-N2,4,6-TETRANITROANILINE/NITRAMINE	0.520000	0.095500
NITROBENZENE	0.520000	0.770000
<hr/> <hr/> <b>METAL</b>		
ANTIMONY	1.710000	25.600000
ARSENIC	0.109500	1.545000
BARIUM	1.130000	0.760000
BERYLLIUM	0.039000	0.171000
CADMIUM	0.212000	1.335000
CALCIUM	0.000000	0.000000
CESIUM	0.000000	0.000000
CHROMIUM	1.950000	2.235000
COPPER	0.980000	2.145000
IRON	0.945000	12.300000
LEAD	0.000000	2.370000
MANGNESIUM	0.000000	0.000000
MERCURY	0.012950	0.283000
NICKEL	1.230000	4.380000
SELENIUM	25.350000	2.050000
SILVER	0.000000	0.158000
SODIUM	0.000000	0.000000
THALLIUM	8.300000	56.800000
TITANIUM	0.000000	0.000000
ZINC	3.980000	9.370000

Tooele North  
Certified Reporting Limits

Analyte Name	Soils CRL (UG/G)	Water CRL (UG/L)
<hr/> <hr/> PESTICIDE/PCB		
	0.000000	0.000000
	0.000000	0.000000
	0.000000	0.000000
	0.000000	0.000000
2,2-BIS (PARA-CHLOROPHENYL) -1,1,1-TRICHLOROETHANE	0.100000	0.100000
2,2-BIS (PARA-CHLOROPHENYL) -1,1-DICHLOROETHANE	0.005050	0.010050
2,2-BIS (PARA-CHLOROPHENYL) -1,1-DICHLOROETHENE	0.001995	0.044000
ALDRIN	0.004035	0.002450
ALPHA CHLORDANE	0.000920	0.001005
ALPHA-BENZENEHEXACHLORIDE/ALPHA-HEXACHLOROCYCLOHEXAN	0.002525	0.002805
ALPHA-ENDOSULFAN/ENDOSULFAN I	0.050000	0.050000
BETA-BENZENEHEXACHLORIDE/BETA-HEXACHLOROCYCLOHEXANE	0.050000	0.050000
BETA-ENDOSULFAN/ENDOSULFAN II	0.100000	0.100000
DECACHLOROBEIPHENYL	0.000000	0.000000
DELTA-BENZENEHEXACHLORIDE/DELTA-HEXACHLOROCYCLOHEXAN	0.002450	0.018450
DIBUTYLCHLORNEDATE	0.000000	0.000000
DIELDRIN	0.002595	0.010900
ENDOSULFAN SULFATE	0.100000	0.100000
ENDRIN	0.003770	0.003820
ENDRIN ALDEHYDE	0.000000	0.000000
ENDRIN KETONE	0.100000	0.100000
GAMMA-CHLORDANE	0.001900	0.015450
HEPTACHLOR	0.000575	0.004205
HEPTACHLOREPOXIDE	0.001775	0.030500
ISODRIN	0.000000	0.000000
LINDANE/GAMA-BENZENEHEXACHLORIDE/GAMMA-HEXACHLOROCYC	0.002325	0.016500
METHOXYCHLOR	0.500000	0.500000
PCB 1016	0.035200	0.034050
PCB 1260	0.026900	0.037700
POLYCHLORINATED BIPHENYL 1221	0.050000	0.050000
POLYCHLORINATED BIPHENYL 1232	0.050000	0.050000
POLYCHLORINATED BIPHENYL 1242	0.050000	0.050000
POLYCHLORINATED BIPHENYL 1248	0.050000	0.050000
POLYCHLORINATED BIPHENYL 1254	0.050000	0.050000
TETRACHLOROMETAXYLENE/2,4,5,6TETRACHLOROMETTAXYLENE	0.000000	0.000000
TOXAPHENE	0.250000	1.000000
<hr/> <hr/> PH		
pH	0.000000	0.000000
<hr/> <hr/> SEMIVOLATILE ORGANIC		
1,2,3-TRICHLOROBENZENE	0.000000	0.000000
1,2,4-TRICHLOROBENZENE	0.145000	1.400000
1,2-DICHLOROBENZENE	0.165000	5.000000
1,3-DICHLOROBENZENE	0.165000	4.250000
1,3-DICHLOROBENZENE-D4	0.000000	0.000000

Tooele North  
Certified Reporting Limits

Analyte Name	Soils CRL (UG/G)	Water CRL (UG/L)
1,4-DICHLOROBENZENE	0.160000	2.200000
1,4-OXATHIANE	0.000000	0.000000
1-METHYLNAPHTHALENES	0.000000	0.000000
2,4,5-TRICHLOROPHENOL	1.700000	10.000000
2,4,6-TRICHLOROPHENOL	0.330000	10.000000
2,4-DICHLOROPHENOL	0.330000	10.000000
2,4-DIMETHYLPHENOL	0.330000	10.000000
2,4-DINITROPHENOL	1.700000	50.000000
2,4-DINITROTOLUENE	0.195000	5.500000
2,6-DINITROTOLUENE	0.265000	3.300000
2-CHLORONAPHTHALENE	0.330000	10.000000
2-CHLOROPHENOL	0.160000	9.600000
2-METHYLNAPHTHALENE	0.330000	10.000000
2-METHYLPHENOL/2-CRESOL	0.330000	10.000000
2-NITROANILINE	1.700000	50.000000
2-NITROPHENOL	0.330000	10.000000
3,3-CICHLOROBENZIDINE	0.200000	6.000000
3-NITROANILINE	0.000000	0.000000
3-NITROTOLUENE	1.700000	50.000000
4,6-DINITRO-2-CRESOL/METHYL-4,6-DINITROPHENOL	1.700000	50.000000
4-BROMOPHENYLPHENYL ETHER	0.330000	10.000000
4-CHLORO-3-CRESOL/3-METHYL-4-CHLOROPHENOL	0.330000	10.000000
4-CHLOROANILINE	0.330000	10.000000
4-CHLOROPHENYLMETHYL SULFIDE	0.000000	0.000000
4-CHLOROPHENYLMETHYL SULFONE	0.000000	0.000000
4-CHLOROPHENYLMETHYL SULFOXIDE	0.000000	0.000000
4-CHLOROPHENYLPHENYL ETHER	0.330000	10.000000
4-METHYLPHENOL/4-CRESOL	0.330000	10.000000
4-NITROANILINE	1.700000	50.000000
4-NITROPHENOL	1.700000	50.000000
ACENAPHTHYLENE	0.230000	10.000000
ACENEPHTHENE	0.205000	9.500000
ANTHRACENE	0.270000	7.000000
BENZO [A] ANTHRACENE	0.150000	20.000000
BENZO [A] PYRENE	0.190000	10.000000
BENZO [B] FLUORANTHENE	0.180000	23.000000
BENZO [G,H,I] PERYLENE	0.120000	16.000000
BENZO [K] FLUORANTHENE	0.330000	21.000000
BENZOIC ACID	1.700000	50.000000
BENZYL ALCOHOL	0.330000	10.000000
BIS (2-CHLOROETHOXY) METHANE	0.330000	10.000000
BIS (2-CHLOROETHYL) ETHER	0.165000	3.550000
BIS (2-CHLOROISOPROPYL) ETHER	0.330000	10.000000
BIS (2-ETHYHEXYL) PHTHALATE	0.195000	10.500000
BUTYLBENZYL PHTHALATE	0.330000	10.000000
CHRYSENE	0.225000	15.000000
CYCLOHEXANONE	0.000000	0.000000
DI-N-BUTYL PHTHALATE	0.330000	10.000000

Tooele North  
Certified Reporting Limits

Analyte Name	Soils CRL (UG/G)	Water CRL (UG/L)
DI-N-OCTYL PHTHALATE	0.295000	15.000000
DI-N-OCTYL PHTHALATE-D4	0.000000	0.000000
DIBENZ [AH] ANTHRACENE	0.100000	7.500000
DIBENZOFURAN	0.330000	10.000000
DIETHYL PHTHALATE	0.330000	10.000000
DIETHYL PHTHALATE-D4	0.000000	0.000000
DIMETHYL PHTHALATE	0.330000	10.000000
DIMETHYLNAPHTHALENES	0.000000	0.000000
DITHIANE	0.000000	0.000000
FLUORANTHENE	0.260000	20.000000
FLUORENE	0.330000	10.000000
HEXACHLOROBENZENE	0.130000	7.500000
HEXACHLOROBUTADIENE	0.210000	3.600000
HEXACHLOROCYCLOPENTADIENE	0.330000	10.000000
HEXACHLOROETHANE	0.200000	2.550000
INDENO [1,2,3-C,D] PYRENE	0.105000	7.200000
ISOPHORONE	0.330000	10.000000
MALATHION	0.000000	0.000000
METHYLNAPHTHALENES	0.000000	0.000000
N-NITROSO DIPHENYLAMINE	0.330000	10.000000
NAPHTHALENE	0.210000	8.500000
NITROBENZENE	0.000000	0.000000
NITROBENZENE-D5	0.000000	0.000000
NITROSO DI-N-PROPYLAMINE	0.330000	10.000000
PARATHION	0.000000	0.000000
PENTACHLOROPHENOL	1.700000	50.000000
PHENANTHRENE	0.205000	8.500000
PHENOL	0.330000	10.000000
PYRENE	0.210000	17.000000
TRIMETHYLNAPHTHALENES	0.000000	0.000000
XYLENE	0.000000	0.000000
<hr/>		
=====TOC		
TOTAL ORGANIC COMPOUNDS	0.000000	0.000000
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=====TPHC		
TOTAL PETROLEUM HYDROCARBONS	0.000000	0.000000
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=====VOLATILE ORGANIC		
1,1,1-TRICHLOROETHANE	0.002100	2.050000
1,1,2,2-TETRACHLOROETHANE	0.000800	2.350000
1,1,2-TRICHLOROETHANE	0.010000	0.310000
1,1-DICHLOROETHANE	0.000850	0.550000
1,1-DICHLOROETHYLENE/1,1-DICHLOROETHENE	0.009500	0.708000
1,2-DICHLOROETHANE	0.001550	3.800000
1,2-DICHLOROETHANE-D4	0.000000	0.000000
1,2-DICHLOROETHYLENES (CIS AND TRANS ISOMERS)	0.001000	0.550000
1,2-DICHLOROPROPANE	0.001100	1.400000

Tooele North  
Certified Reporting Limits

Analyte Name	Soils CRL (UG/G)	Water CRL (UG/L)
1,2-DIMETHYLBENZENE/O-XYLENE	0.000000	0.000000
1,3-DICHLOROPROPANE	0.000000	0.000000
1,3-DIMETHYLBENZENE/M-XYLENE	0.000000	0.000000
2-CHLOROETHYL VINYL ETHER/(2-CHLOROETHOXY) ETHENE	0.024000	41.000000
ACETIC ACID VINYL ESTER/VINYL ACETATE	0.010000	10.000000
ACETONE	0.010000	10.000000
BENZENE	0.001450	1.200000
BROMODICHLOROMETHANE	0.001650	3.950000
BROMOFORM	0.009000	4.100000
BROMOMETHANE	0.010000	10.000000
CARBON DISULFIDE	0.005000	5.000000
CARBON TETRACHLORIDE	0.002800	1.800000
CHLOROBENZENE	0.001400	0.700000
CHLOROETHANE	0.013500	1.100000
CHLOROETHENE/VINYL CHLORIDE	0.007500	0.250000
CHLOROFORM	0.001150	0.415000
CHLOROMETHANE	0.017000	1.600000
CIS-1,2-DICHLOROETHYLENE/CIS-1,2-DICHLOROETHENE	0.000000	0.000000
CIS-1,3-DICHLOROPROPYLENE/CIS-1,3-DICHLOROPROPENE	0.000650	1.900000
DIBROMOCHLOROMETHANE	0.007000	3.250000
ETHYLBENZENE	0.001650	4.650000
ETHYLBENZENE-D10	0.000000	0.000000
METHYL-N-BUTYL KETONE/2-HEXANONE	0.010000	10.000000
METHYLENE CHLORIDE	0.002850	2.700000
METHYLENE CHLORIDE-D2	0.000000	0.000000
METHYLETHYL KETONE/2-BUTANONE	0.010000	10.000000
METHYLISOBUTYL KETONE	0.010000	10.000000
STYRENE	0.005000	5.000000
TETRACHLOROETHYLENE/TETRACHLOROETHENE	0.000950	0.250000
TOLUENE	0.004200	4.350000
TOLUENE-D8	0.000000	0.000000
TRANS-1,3-DICHLOROPROPENE	0.005000	5.000000
TRICHLOROETHYLENE/TRICHLOROETHENE	0.001900	0.250000

